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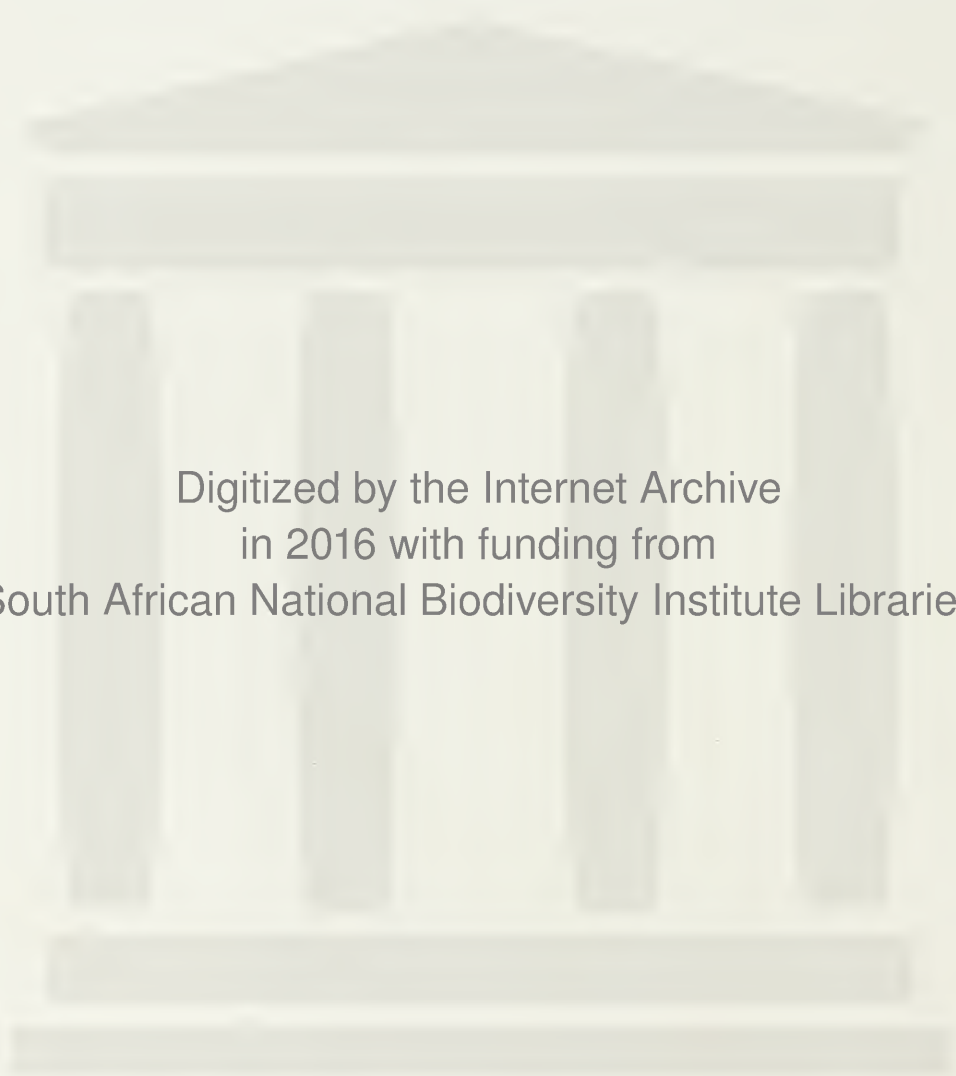
A CLASSIFICATION
OF THE
MOUNTAIN VEGETATION
OF THE
FYNBOS BIOME

B.M. CAMPBELL

BOTANICAL RESEARCH INSTITUTE — DEPARTMENT OF AGRICULTURE AND WATER SUPPLY — REPUBLIC OF
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A CLASSIFICATION OF THE MOUNTAIN VEGETATION OF THE FYNBOS BIOME

by

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Foreword

This Memoir represents the final results of a research project that was launched in the late 1970's in response to a need for a classification of the mountain vegetation of the Fynbos Biome expressed particularly by researchers and foresters responsible for managing the vegetation in mountain catchments. The richness of the flora, the often restricted distribution pattern of taxa and the superficial similarity of even very distinct taxa makes it extremely difficult to create a classification of fynbos based on floristic criteria. Furthermore, a floristic classification is usable only by the few specialists who have a good working knowledge of the fynbos. For these reasons, a classification based on the structural and functional attributes of vegetation, which can be easily observed by workers with a more limited botanical knowledge, had become a necessity. Even in this simplified form, the task allocated to the author of this Memoir remained a formidable one. From the time Mr Campbell was put in charge of the project, he has shown a tenacity of purpose as well as a strong innovative flair which made the successful completion of the task possible.

With great perseverance he gathered ecological data along the entire extent of the mountains in the Fynbos Biome and, by innovation, solved the problems of handling the large data matrices involved. He has made an impressive contribution towards the understanding of some of the many baffling problems posed by the complex and diverse mountain fynbos. When the size of the area studied, the complexity of the vegetation and the rapid pace at which the work was completed are taken into account, it is understandable that the level of sampling undertaken was perforce relatively low. Further studies to substantiate the results must therefore be envisaged. Mr Campbell has set the tone for future work on the structural-functional classification of the fynbos. This Memoir is likely to be a standard work in the field for years to come. It is to be hoped that it will be widely used by managers and researchers working in the mountain fynbos and in this way will contribute substantially towards conserving the Cape Floristic Kingdom for future generations.

B. DE WINTER

Director: Botanical Research Institute

Pretoria, November 1984

Abstract

CAMPBELL, B.M., 1984. A classification of the mountain vegetation of the Fynbos Biome. *Mem. bot. Surv. S. Afr.* No. 50, pp.121.

Keywords: classification, communities, Fynbos, heathland, higher taxa, structure

The mountain vegetation of the Fynbos Biome is classified and described. Structural, floristic and environmental data were collected in 507 plots. The classification is mostly based on structural data and some higher taxa (e.g. families such as Ericaceae and Penaeaceae) and was produced using the Braun-Blanquet table sorting technique. Each community is described according to its stratification, formation, differentiating features, dominant taxa, distribution, environment and synonymy. Keys to identifying the communities are provided.

The classification is hierarchical and communities at the various hierarchical levels are termed groups, subgroups, series, subseries and types. Four groups are recognized, one of which is Fynbos and three of which are non-fynbos viz Forest & Thicket, Karroid & Renoster Shrubland and Grassland & Grassy Shrubland. The non-fynbos groups are not extensive in the mountains and are subdivided to the series level.

Fynbos is subdivided into two subgroups, namely Eastern Fynbos and Mountain Fynbos. Eastern Fynbos consists of only one series, Grassy Fynbos and, as the names imply, it is a grassy community more or less restricted to the east. Grassy Fynbos is often associated with fine-textured soils.

Mountain Fynbos is subdivided into five series, viz Asteraceous Fynbos, Restioid Fynbos, Ericaceous Fynbos, Proteoid Fynbos and Closed-Scrub Fynbos. Asteraceous Fynbos is dominated by shrubs and is found on the driest and most mesotrophic fynbos sites. Restioid Fynbos is found under wetter conditions and is dominated by restioids. At the most mesic extreme, another shrub-dominated community is found but in this case the shrubs are mostly Ericaceae. Proteoid Fynbos is often also associated with mesic conditions but a relatively deep soil is also characteristic. Closed-Scrub Fynbos is found along streams and rivers and, like Proteoid Fynbos, it is often dominated by tall shrubs but in the case of Closed-Scrub Fynbos the tall shrubs are non-proteoid.

The Fynbos Group is subdivided into 16 subseries and 63 types. The subseries are indicated by environmental terms, e.g. Wet Ericaceous Fynbos, and the types are all given unique place names e.g. Ruitersberg Wet Ericaceous Fynbos.

On the basis of an analysis of the distribution of communities, seven mountain regions are recognized. Each region is characterized by a specific combination of communities.

Uittreksel

Die bergplantegroei van die Fynbosbioom is geklassifiseer en beskryf. Strukturele-, floristiese- en omgewingsdata is in 507 persele versamel. Die klassifikasie is hoofsaaklik op strukturele data en sommige hoër taksons (bv. die families Ericaceae en Penaeaceae) gebaseer en daar is van die Braun-Blanquet-metode gebruik gemaak. Elke gemeenskap is aan die hand van die verskillende stratus, formasietipe, differensiërende kenmerke, dominante taksons, geografiese verspreiding, omgewingsfaktore en sinonimie beskryf. Sleutels om die gemeenskappe te identifiseer word verskaf.

In die hiërgargiese klassifikasie staan die gemeenskappe van die verskillende hiërgargiese vlakke as groepe, subgroepe, series, subseries en tipes bekend. Vier groepe is onderskei waarvan een Fynbos is en die ander drie nie-fynbos is, nl. Woud en Ruigte; Karoo-agtige en Renosterbosstruikveld; Grasveld en Grasagtige Struikveld. Die kleiner nie-fynbosgroepe in die berge word tot op serievlak onderverdeel.

Die Fynbos word onderverdeel in die subgroep Oostelike-fynbos en die subgroep Bergfynbos. Die Oostelike-fynbos sluit slegs een serie, die Grasagtige-Fynbos, in en, soos die naam aandui, verteenwoordig dit 'n grasagtige gemeenskap, wat min of meer beperk is tot die oostelike dele en kom in assosiasie met fyntekstuur-gronde voor.

Die Bergfynbos word in vyf series onderverdeel, naamlik Asteragtige-, Restioïede-, Erikoïede- en Proteoïede-Fynbos en Geslote-struikveldfynbos. Die Asteragtige-fynbos word gedomineer deur struie en word op die droogste en mees mesotrofiese fynbos groeiplekke aangetref. Die Restioïede-fynbos word onder vogtiger toestande aangetref en word gedomineer deur restioïede. Onder die vogtigste toestande word 'n verdere gemeenskap gedomineer deur erikoïede-struie gevind. Die Proteoïede-fynbos is dikwels met vogtige toestande geassosieer, maar 'n relatief diep grond is 'n verdere kenmerk. Die Geslote-struikveldfynbos kom langs spruite en riviere voor en, soos in die geval van die Proteoïede-fynbos, word dit gekenmerk deur groot struie, maar in dié geval nie deur proteoïede soorte nie.

Die Fynbos word onderverdeel in 16 subseries en 60 tipes. Die subseries word onderskei aan die hand van omgewingskenmerke bv. Nat-erikoïede-fynbos terwyl die tipes aan plekname gekoppel word bv. Ruitersberg-nat-erikoïede-fynbos.

Op grond van die verspreiding van die gemeenskappe is sewe bergstreek onderskei. Elke bergstreek word deur 'n spesifieke kombinasie van gemeenskappe onderskei.

Study area

This study is complete for all the mountain vegetation of the Cape Floristic Region. Patches of mountain fynbos outside this region (see Acocks's map of 1953 & 1975) and their abutting vegetation have been included in the study, thus also making the study complete for all mountain fynbos mapped by Acocks (Fig. 1). The vegetation of the study area is predominantly fynbos but also includes grassland, forest and various dry non-fynbos shrublands. All these non-fynbos types, unlike fynbos, are not zonal in the study area. The mountains studied comprise approximately 4,0 million hectares. 'Fynbos Biome' denotes the same geographical area as 'Cape Floristic Region' (Kruger, 1979b).

A detailed environmental analysis of the study area has been described by Campbell (1983). A brief description of the mountain environments follows.

The mountains of the region are of the Cape Folded Belt, the characteristics of which are conferred mainly by the quartzites of the Table Mountain (T.M.) Group and Witteberg Group (quartzites of the Cape Super-

group). The T.M. Group is the dominant geological formation; it is only the relatively minor interior ranges that are of the Witteberg Group. The quartzites generally give rise to soils that are acidic, nutrient-poor, coarse-grained, rocky and shallow. In the T.M. quartzites clay and silt contents increase towards the east (from sands and loamy sands in the west to loamy sands and sandy clay loams in the east). Soils tend to be better developed (less rocky, greater depth, greater clay content) on the south aspects, on the lower mountain slopes and on the gentler slopes. Clay-rich soils (e.g. sandy clay loams) are limited in extent, being mostly restricted to shales and granites, which in the study area are largely confined to the lower mountain slopes. There is one prominent high altitude shaleband in the T.M. Group and there are several shalebands in the Witteberg Group.

In the west, the mountains are extremely broken. High cliffs, bouldery lower slopes, and prominent scarps and crests contrast with extensive basins and subsummit plateaux (Fig. 2). In the south and south-east, the mountains (especially the moister coastal mountains)



FIG. 2.—Some mountains of the north-west. High cliffs and bouldery lower slopes are a common feature in the north-west. This example, from the Cedarberg, shows some typical Restioid Fynbos in the foreground (see Chapter 10).

FIG. 3.—Mountains of the southern coastal region. Steep but well vegetated slopes are characteristic of this region. In this example from the Tsitsikamma, the south aspects (in shadow) and the north aspects are vegetated with Ericaceous Fynbos at high altitudes and Proteoid Fynbos at lower altitudes.



are less broken, with the steep southerly slopes being well vegetated (Fig. 3). Maximum elevations in the study area are of the order of 2 000 m.

The climate of the region varies from a typically mediterranean type in the north and south-west to being a uniform rainfall type in the east (Fig. 1). Throughout the region there are marked rainfall gradients in response to the altitude gradients (e.g. 300 mm to over 1 500 mm).

Mean annual temperatures vary from 15°C to 16°C at the coast to 17°C to 18°C at inland stations and to less than 13°C at high altitudes. Annual radiation loads of north slopes may be more than double those of south slopes (Kruger, 1974; Fuggle & Ashton, 1979). Mists do much to alleviate the hot and dry summers especially in the coastal ranges. Further details on the mountain environments can be found in Campbell (1983), Kruger (1979a) and Day *et al.* (1979).

Chapter 3

Methods

Data collection

The location of the 22 transects on which a total of 507 plots were sampled is shown in Fig. 1. A transect-based approach was used to reduce the field sampling period and to facilitate the possibility of using direct ordination techniques (Campbell, in prep.). At least one transect was placed in each of the preliminary phytogeographical zones which could be recognized (Fig. 1).

Each transect covers an altitude gradient. On each transect the geological formations present and the dominant slope aspects were sampled. Azonal vegetation (Walter, 1973), here taken to be that vegetation which occurs independently of the climate and dominant geological formation, e.g. riverine and shaleband vegetation, was sampled if it occurred along the transect. About 80 of the 507 plots come from azonal vegetation.

Unfortunately many transects could not be aligned on neat altitude gradients because of problems of accessibility and because of the lack of mature fynbos (fynbos older than 10 years). Only mature fynbos was sampled in this study because of the profound structural changes that occur during the post-fire succession (Kruger, 1979a). The restriction of the classification to mature fynbos is the major limitation of the classification as there are vast areas in the mountains that are covered by immature fynbos. A general lack of mature vegetation occurred in the Suurberg, Grahamstown, Winterhoek (East) and Kouga areas (Fig. 1).

Each 10 × 5 m plot was placed subjectively in mature stands of vegetation which appeared uniform with respect to habitat, structure and floristics. 10 × 5 m is the size commonly used in phytosociological surveys in fynbos (e.g. Boucher, 1978; Bond, 1981).

At each plot, environmental, floristic and structural data were collected. The environmental data collected are described in Campbell (1983).

All cover-dominant species (greater than 10% of the total cover) and all emergent species were assigned an estimated projected canopy cover and were collected for identification. Most of the data collected were structural characters of the vegetation, with further subdivisions of

some of these characters by the use of higher-level taxonomic groups (e.g. non-ericaceous ericoid-leaved shrubs). It is from these structural (-cum-floristic) characters that the classification has, in the major part, been produced. These characters are described in Chapter 4. For each character, an estimated projected canopy cover was recorded such that, in the analysis, the characters could be combined in various ways (e.g. total aphyllous plants, total cover below 0,25 m).

Production of the classification

The classification was produced using the table-sorting methods of the Braun-Blanquet approach (Werger, 1974) except that the table was a structure (cum-floristic) by plot table, not a species by plot table. The table sorting was accomplished using a computer program in which the user specifies the sequences of plots and characters that are required (Campbell, 1982; Van der Meulen *et al.*, 1978).

The tables are, by Braun-Blanquet standards, extremely poor. With classifications using species there are numerous species that are relatively restricted to certain communities. When one uses structure or higher taxa as characters the variation between plots is largely quantitative not qualitative. Therefore, unlike tables produced with species, in which patterns of presence and absence are often sufficient to indicate the groupings of the classification, tables produced with structural characters show no such clear patterns and one has to read quantities in order to distinguish the groupings of the classification. I have partly resolved this by presenting, in the final tables, characters combined with character states, e.g. leptophylls with greater than 50% cover.

Another problem with structural characters is that it is often relative cover that is more meaningful than absolute cover. For instance a plot with a low restioid cover and a low total cover may best be regarded as Restioid Fynbos, i.e. the important characteristic is the high relative restioid cover. Furthermore, it is not only relativization by total cover that is important. For instance, a plot with a low grass cover and an even lower restioid cover may best be regarded as Grassy Fynbos, i.e. the important characteristic is the high grass cover relative to the restioid cover. In the early stages of the

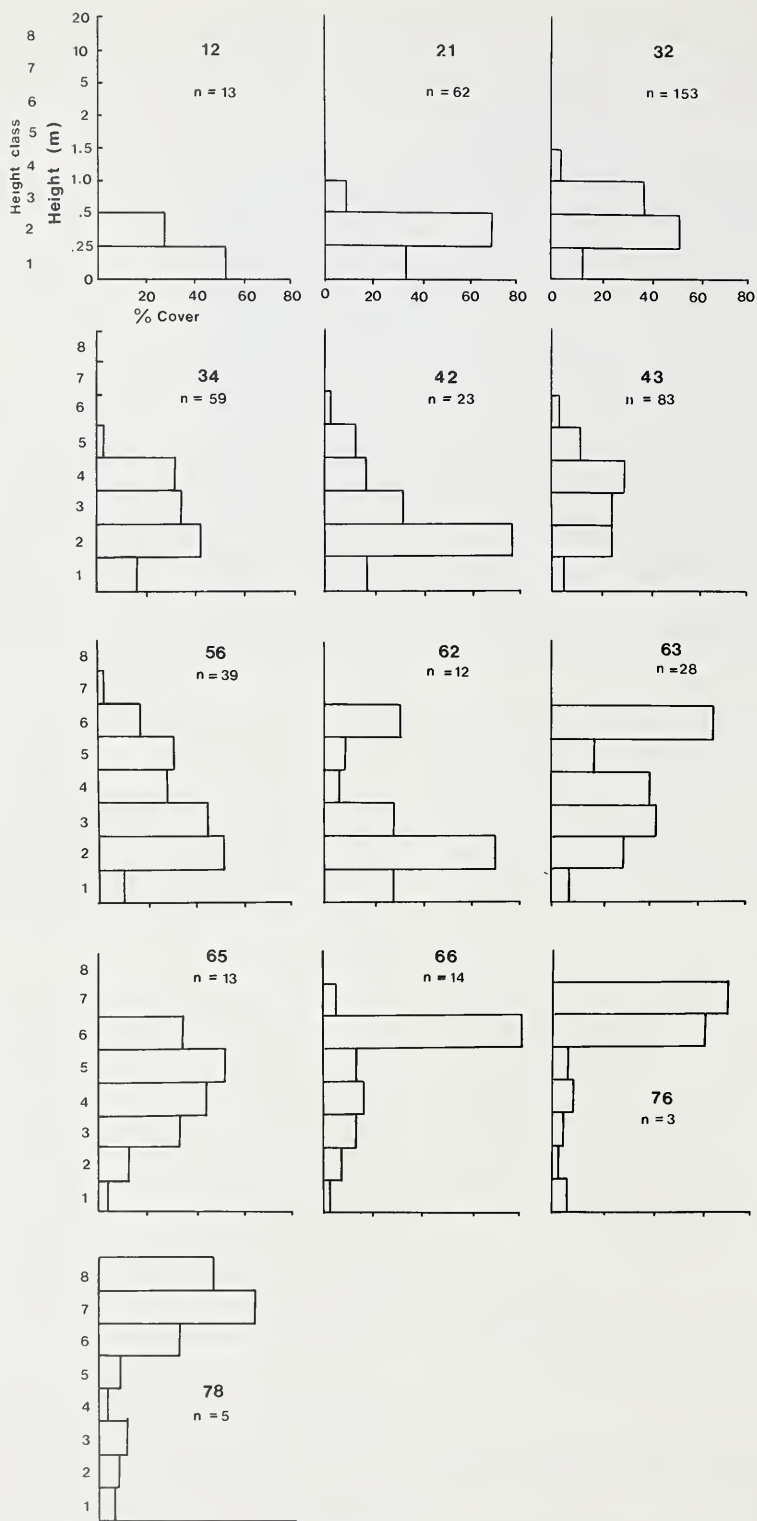


FIG. 4.—The 13 stratification classes derived from TWINSpan. Each stratification class is referenced by two numerals. The histograms show average cover by height class; cover being averaged over all the plots placed in a stratification class. The eight height classes recorded in the field are shown.

table sorting I used cover relativized by total cover but in the final tables I have used absolute cover except in the case of a few characters. The use of absolute cover is the more pragmatic approach as the tables can be used directly in the field for identifying types. Some plots that appear to be peculiarly placed in the final table may well be examples in which relative cover is important.

Further details of the methodology, the relationship of the final classification to numerically-defined classifications, and the testing of the classification can be found in Campbell (1985a).

Presentation of the classification

Community nomenclature

The classification is hierarchical and to indicate the various hierarchical levels the rather neutral terms group, subgroup, series, subseries and type have been used. 'Group' indicates the most broadly-defined communities and, at the other extreme, 'type' indicates the most narrowly-defined communities. I have thus avoided the implications of much of the current terminology (association, formation, etc.). The term community is here used to designate a community-type of any hierarchical level.

At the group, subgroup, series and subseries level, community names are generally descriptive, with the descriptors being structural, environmental or occasionally floristic terms. For the sake of brevity, it was not possible to standardize on the naming system. At the type level it is not possible to have descriptive names unless one is willing to have rather cumbersome names, e.g. non-ericaceous shrubland with low grass cover and high restioid cover. Because of the floristic diversity within a type, it is also not possible to use floristic names. To circumvent these problems, I have used place names for types, e.g. Jonkershoek, Ruitersberg. Reference to a type can be made without using its subseries or series name. However, as the number of types is fairly large, communication may be easier by combining the type and subseries name (or the subseries abbreviation): for example, Ruitersberg Wet Ericaceous Fynbos or Ruitersberg Ew. In non-fynbos types I have given place names to those communities that appear to be restricted to the mountains even if they are above the type hierarchical level at present. Those communities which are chiefly of non-mountain environments have been given descriptive titles e.g. Renoster Shrubland. The suggestion implicit in this naming of the non-fynbos communities is that with further classificatory work, especially in the non-mountain areas, our current concepts of the communities and the hierarchy will undergo much revision: this revision is least likely to occur in those communities given place names.

In using place names and abbreviations (alphabetical or alphanumeric codes), I have followed certain traditions of geologists and pedologists (Amer. Comm. Stratig. Nomen., 1961; MacVicar *et al.*, 1977). However, I do not imply that something analogous to a type specimen or type profile can be found. Vegetation change is too rapid to allow for a type specimen system. Nevertheless,

the names that I have selected do come from areas where the named type is commonly found.

Describing the communities

Each community recognized has been described in a standard manner under the headings stratification, formation, differentiating features, floristics, distribution, environment and synonymy.

Under the heading 'stratification', one or more of the 13 stratification classes are listed. These classes are illustrated in Fig. 4. The classes are referenced by two numerals from 1 to 8. These numerals represent the 8 height classes recorded in the field, and the class reference gives a rough idea of the type of stratification that characterizes a stratification class (Fig. 4). The 13 classes were derived using the divisive polythetic classification technique of TWINSpan (Hill, 1979; Gauch & Whitaker, 1981). The 8 height classes were used as the classificatory attributes. TWINSpan is not entirely appropriate, as variation in cover (i.e. quantitative not qualitative variation) is important in distinguishing different types of stratification and TWINSpan can only marginally incorporate quantities. This is done by the incorporation of so-called pseudospecies, i.e. different attribute states of the same attribute (Hill, 1979). The pseudospecies cut-off levels selected in the present analysis were 5%, 12%, 25%, 50% and 75%. TWINSpan was one of the few classificatory methods available that could handle all 500 plots.

Under the heading 'formation', the structural formation of the community has been given using the *a priori* system devised for the Fynbos Biome (Campbell *et al.*, 1981). The essentials of the system, which follows the heathland system of Specht (1979), are given in Table 1.

The features which distinguish the communities recognized are referred to as differentiating features. They are analogous to the differential species in traditional phytosociology (Werger, 1974), and are, in most cases, characters combined with character states.

The more constant dominant taxa are recorded under the heading 'floristics*'. A dominant species is taken to be a species with cover greater than 10% of the total cover. The more constant emergent species, if present, are also indicated. They are included because of their importance in determining vegetation physiognomy.

Under 'distribution', the distribution of a community is indicated by a distribution map and by reference to the seven mountain regions that I recognize in the Fynbos Biome (Fig. 5). The derivation of these mountain regions is discussed in Chapter 14. The distribution maps were constructed using the initial 507 plots and the subsequent field checking of the classification.

Under 'synonymy', I attempt to relate my concepts of communities to those which have been previously

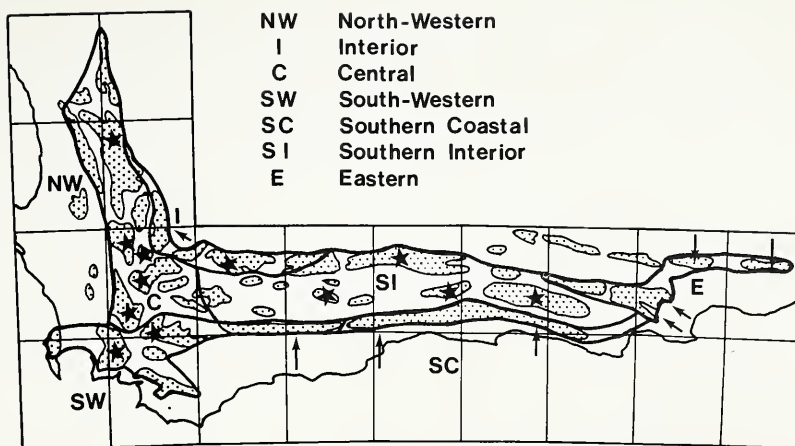
* Many of the dominant species belong to the Restionaceae, a family currently under revision, and therefore the correct names for some taxa cannot be established at this stage.

TABLE 1.—The standard nomenclature used to characterize the structure of the recognized communities (Campbell *et al.*, 1981). This nomenclature is used in the text under the headings 'Formation'

Growth form of the dominant stratum (3)	Projected canopy cover of the dominant stratum (3)			
	100–75% interlocking crowns	75–50% crowns not interlocking	50–25%	25–5% 5–0,1%
tall trees >10 m	tall forest	closed woodland tall mid-dense shrubland mid-high mid-dense shrubland low mid-dense shrubland dwarf mid-dense shrubland mid-dense graminoid shrubland mid-dense herbland	closed woodland	open woodland
low trees <10 m	low forest		tall open shrubland	tall sparse shrubland
tall shrubs >2 m	tall closed shrubland (1)		mid-high open shrubland	mid-high sparse shrubland
mid-high shrubs 1–2 m	mid-high closed shrubland		low open shrubland	low sparse shrubland
low shrubs 25–100 cm	low closed shrubland		dwarf open shrubland	dwarf sparse shrubland
dwarf shrubs <25 cm	dwarf closed shrubland	(2)	open graminoid shrubland	sparse graminoid shrubland
shrubs and graminoids co-dominant (5)	closed graminoid shrubland (2)		open herbland	sparse herbland
graminoids	closed herbland (2)			(4)

- (1) When greater sophistication is required, further terms such as small-leaved, large-leaved, succulent, proteoid and ericoid are appended to shrubland (e.g. low open small-leaved shrubland).
- (2) The term graminoid is replaced by restioid, grassy or cyperoid, depending on the dominant graminoid. Similarly, herbland can be replaced by restioid, grassland or sedgeland.
- (3) When reference to strata other than the dominant stratum is intended, the same terminology for canopy cover and height is used, but the suffix 'land' is dropped and the terms overstorey or understorey are used if necessary.
- (4) When reference to low-cover shrubs or graminoids (less than 5%) is intended, then 'very sparse' or, if the components are emergents, then 'emergent' is used.
- (5) The graminoid shrubland formations are given a height class description as for the shrubland formations. The graminoid formations are also given height class descriptions (0–0,25 m: dwarf; 0,25–1,0 m: mid-high; >1,0 m: tall; >2,0 m: very tall).

FIG. 5.—The seven mountain regions of the Fynbos Biome. The regions recognized apply only to the mountains within the designated area and the boundaries are somewhat arbitrary as detailed field checking has not been possible. The distribution of the transects used to derive the regions is shown (arrows or stars) and the method of derivation is discussed in Chapter 14.



published. Relatively detailed descriptive works for the entire Biome are Boucher & Moll (1981), Kruger (1979a) and Taylor (1978). However, the most important references for synonymy have been the works based on the Braun-Blanquet approach because, in these, it is possible to scrutinize species listings from relevés and thereby determine more exact synonymy. The south-west is well-covered by the phytosociological works of Boucher (1978) for the Cape Hangklip area, Kruger (1974) for the Jakkalsrivier catchment area, Werger *et al.* (1972) for a catchment in Jonkershoek, and the works of Laidler *et al.* (1978), Glyphis *et al.* (1978) and McKenzie *et al.* (1977) for Table Mountain. The problem with all these phytosociological accounts is that they include immature fynbos and therefore synonymy is not always easy to determine. In the south, the work of Bond (1981) for the Outeniquas and Swartberg is the main reference, and there are a few plots available from the Rooiberg (Taylor & Van der Meulen, 1981). Cowling's (1984) work from the Humansdorp Region is the only phyto-

sociological work from the east. Unfortunately for my study, Cowling's work is mainly based on the lowlands and it includes much immature vegetation. Vast areas of the south and east are not covered by phytosociological surveys and there are no surveys north of the South-Western Mountain Region (cf. Fig. 5).

For each major grouping of communities, a key to the communities is provided. All the chapters containing keys are referenced in Fig. 7. The key has been constructed with the data from the 507 plots and, in addition, a further 47 plots have been used to test the key. Unfortunately, the key has not been subjected to stringent field testing. The use of the key is mostly self explanatory. There are generally a number of steps of the same level to be selected from. The user starts at step 1 and, if the conditions are not met, moves on to step 2 and so on until the conditions are met. An overall guide to using the classification and an introduction to another key (a computerized key) are to be found in Appendix 1.

Taxonomic characters

In this chapter, I describe the taxonomic* characters or attributes that have been used to arrive at the vegetation classification. As stated earlier, the object of the study was to develop a classification based on non-floristic vegetation characters. It was apparent almost immediately that certain higher floristic taxa would have to be utilized as characters and, as the classification developed, it became necessary to use dominant species as characters in one of the fynbos series. It could be argued that the higher taxa do represent structural characters. For instance, Ericaceae could be defined in structural terms, i.e. whorled and ericoid-leaved shrubs. The whorled leaves distinguish Ericaceae from other families that have ericoid leaves. However, at this stage, it would be naive to consider the higher taxa as structural characters because too little is known about the adaptive significance of characters such as whorled leaves.

In the differentiating tables and diagnostic keys to the communities in Chapters 5–13, it can be seen that the diagnostic criteria are: (1) gross community characters or physiognomic characters (e.g. total cover) (2) life-forms or growth-forms (e.g. annual grasses) (3) single structural characters (e.g. spinescence); (4) higher taxa or (5) dominant species. Many of the characters may appear to be illogically defined (e.g. aphyllous grasses are not included with restioids). It will become apparent in the community descriptions why the criteria were defined in certain ways (e.g. aphyllous grasses have an ecological amplitude different from that of restioids). The characters used in the final classification were arrived at during the process of developing the classification. In choosing characters to record in the field I was guided by various hypotheses. In Campbell (1985a) I discuss the overall process of selection of characters for recording in the field and for use in the differentiating tables, and I discuss the philosophical problems associated with the relatively *ad hoc* decisions that had to be made. In Campbell (in prep.) I investigate the functional significance of many of the characters.

Physiognomic characters

Estimated canopy cover of the vegetation, 'total cover', was recorded in the field, and this has been used as a taxonomic character. Another physiognomic charac-

ter available is cover by height class (height classes as indicated in Fig. 4 and Tables 2 & 4). In the field, a plant was assigned to a height class according to the height of its vegetative parts. Height *per se* has been used to subdivide characters (e.g. proteoids > 1.0 m) and total cover by certain height classes has been used as a character. 'Alpine stature' is used in the differentiating tables, and is defined as a stratification in which all the cover is below 0.5 m and >20% cover is below 0.25 m, or a stratification in which >95% cover is below 0.5 m (no cover above 1 m) and >50% cover is below 0.25 m.

Characters of woody plants

Table 2 shows the array of characters of woody plants that were recorded in the field and that have been used, or combined in various ways, in the differentiating tables. A few comments are relevant, especially concerning those characters that are floristic, and those that are structural but which could be defined floristically.

TABLE 2.—Characters of woody plants that were recorded

Height class (Fig. 4)
Leaf size (not recorded for deciduous and succulent leaves; leaf-like phyllodes treated as leaves)
Aphyllous (predominantly stem-photosynthetic)
Green-stemmed (e.g. <i>Mundia spinosa</i>)
Yellow-stemmed, partially parasitic (e.g. <i>Thesium</i>)
Small-leaved (leptophyllous, <25 mm ² in area)
Narrow (leaf length >3X leaf width, e.g. <i>Erica hispidula</i>)
Broad (leaf length <3X leaf width, e.g. <i>Penaea mucronata</i> , <i>Relbunium squarrosa</i>)
Large-leaved
Nanophyllous (26–225 mm ²)
Microphyllous (226–2 025 mm ²)
Mesophyllous (2 026–18 225 mm ²)
Leaf form and arrangement
Ericoid (rolled leaves)
Ericaceae
Asteraceae
Rhamnaceae and Thymelaeaceae (e.g. <i>Phyllaea</i> and <i>Pas-serina</i>)
Grubbiaceae
Other (Rosaceae, Fabaceae)
Elytropappoid (leptophyllous, adpressed, scale-like, pubescent leaves; e.g. <i>Elytropappus rhinocerotis</i> , <i>Helichrysum ericoides</i>)
Stoebeoid (leaves crowded, minute, fascicled, e.g. <i>Stoebe plumosa</i> ; note that many <i>Stoebe</i> spp. would be classed as ericoid)
Cupressoid (<i>Widdringtonia</i> spp.)
Lobed, dissected (e.g. <i>Ursinia anethoides</i> , <i>Serruria</i> spp.)
Other

* 'Taxonomic' is used here in the general sense (cf. OED) and not as in systematic botany.

TABLE 2. (cont.)

Leaf pubescence (not recorded for deciduous, fleshy and proteoid shrubs)
Pubescent on both leaf surfaces
Not as above (not pubescent or pubescent on one surface only)
Leaf texture (see Table 3; texture not recorded for deciduous species)
Orthophyll
Sclerophyll
Fleshy (semi-succulent)
Succulent
Deciduousity
Evergreen
Deciduous (e.g. <i>Grewia robusta</i> , <i>Montinia caryophyllacea</i>)
Spinescence
Leaf spinescence (e.g. some <i>Metalasia</i> , <i>Cliffortia</i> and <i>Aspalathus</i> spp.)
Stem spinescence (e.g. <i>Mundia spinosa</i> , <i>Asparagus</i> spp.)
Special forms
Proteoid (Proteaceae excluding species with leptophyllous or dorsiventral leaves)
Regenerating strategy
Resprout from rootstocks (e.g. <i>Leucadendron salignum</i>)
<i>Protea nitida</i> : resprout from above-ground stems
Seed regeneration
Growth-form
Mat or prostrate (e.g. <i>Protea acaulos</i> , <i>P. cryophila</i>)
Other
Ericaceae
Bruniaceae
Cupressoid-like (e.g. <i>Brunia nodiflora</i>)
Other (e.g. <i>Berzelia lanuginosa</i>)
Penaceae
Climber
Stem succulent (e.g. <i>Euphorbia mauritanica</i>)
Rosulate succulent (megaphylls arranged like the petals of a rose)

Ericoid leaves are subdivided by families. In addition, total Ericaceae have been recorded so as to include all Ericaceae irrespective of leaf form. The Ericaceae category therefore includes leptophylls with or without ericoid leaves. The elytropappoid and cupressoid leaf forms could be floristically defined as the former occurs predominantly in *Elytropappus rhinocerotis* and *E. adpressus*, and the latter only in *Widdringtonia* spp. *Widdringtonia* spp. are the only indigenous Cupressaceae in the study area. The proteoid category includes only Proteaceae, but excludes Bruniaceae with leptophylls (e.g. *Diastella* spp.) or with dorsiventral leaves (*Brabejum*). The category, therefore, comprises essentially large-leaved and isobilateral species. However, lobed-leaved (dissected) and terete-leaved Proteaceae are also included (e.g. *Serruria* spp.). The family Penaceae also receives special attention. The family could possibly be held together by a structural feature, the peculiar leaf type. Taylor (1978) refers to it as the peneoid leaf. The leaves are usually leptophyllous/nanophyllous, ovate, imbricate, acuminate, cordate and decussate. Bruniaceae were also recorded. There are two relatively distinct types. (a) a cupressoid-like group (e.g. *Brunia* spp.) and (b) a non cupressoid-like group in which the leptophylls are terete (e.g. *Berzelia* spp.).

Regenerating strategy appears to be a useful character but is not easily determined for many woody plants and I have only used it in the case of proteoids. *Protea*

nitida forms a character of its own. It is the only proteoid recorded which regenerates from subcortical layers of the trunk and main branches. That it is separated as a distinct structural form is probably justified for, as Kruger (1979a) notes, it has a combination of adaptive traits and features of the life cycle which are rare in fynbos plants.

Of the characters recorded for woody plants, the most subjectively determined character is leaf texture. However, a great degree of consistency in the determination of leaf texture has developed between different workers in the fynbos and Cowling & Campbell (1983) have shown that the textural classes can be operationally defined by using indices of sclerophyllly (leaf dry weight per unit leaf area) and succulence (maximal water content per unit leaf area). The subjective criteria used to determine leaf texture are shown in Table 3. The fleshy category gave the most problems.

Characters of herbaceous plants

Table 4 shows the characters of herbaceous plants that were recorded in the field. As in the previous section, I will comment on those characters which are floristic or which approach being floristic.

The main graminoid classes are essentially floristic: Restionaceae, Poaceae and Cyperaceae. The Restionaceae are wiry, aphyllous, evergreen hemicryptophytes whereas the Poaceae are mostly leafy. The one exception in the Poaceae is *Ehrharta ramosa*, an aphyllous grass that approximates the restioid form. The Cyperaceae have two major forms: a restioid-like form (aphyllous sedges) and a grass-like form (leafy sedges).

In the ferns, *Schizaea* is separated as a category on its own. It is a peculiar restioid-like fern. Of the other ferns ('pinnate ferns') *Pteridium aquilinum* is identified as a separate growth form. It does have a peculiar growth habit but, then, there are many other fern-types which should be given special status. The terete-leaved evergreen geophytes ('bobartioids') all belong to *Bobartia* but not all *Bobartia* spp. are bobartioid.

Dominant species

Dominant species have been used as differentiating characters in only one of the fynbos series *viz* Proteoid Fynbos. The species used (about 15) mostly belong to the Proteaceae and all form part of the canopy layer. As such, they are all mid-high to tall shrubs with greater than 10% cover. Being proteoids, their leaves are predominantly isobilateral and microphyllous or mesophyllous.

The use of dominant species to define vegetation types has a long history (Clements, 1928; Du Rietz, 1921; Tansley, 1920). Fynbos communities defined by proteoids (e.g. *P. repens* Fynbos) represent consociations, consociations being communities dominated by one species but with a rather variable understorey. My Proteoid Fynbos types are usually defined by reference to the dominant species and the understorey.

TABLE 3.—Subjective categorization of leaf texture (from Bond, 1981 and Cowling & Campbell, 1983)

Texture	Characterization and examples
Succulent	Leaves turgid, express copious liquid when squeezed between thumb and forefinger, e.g. species of <i>Delosperma</i> , <i>Mesembryanthemum</i> and <i>Crassula</i> , <i>Euphorbia mauritanica</i>
Fleshy (semi-succulent)	Leaves usually pulpy, little liquid expressed but leaves collapse with a rubbery or gelatinous texture when rolled between thumb and forefinger, e.g. <i>Relbania genistaeifolia</i> , <i>Chrysocoma tenuifolia</i> , <i>Pteronia fasciata</i> , <i>Felicia filifolia</i> , <i>Eriocephalus africanus</i>
Sclerophyll	Leaves hard, coriaceous and thick, breaking when folded, e.g. species of <i>Protea</i> , <i>Phyllica</i> and <i>Passerina</i> , <i>Sideroxylon inerme</i>
Orthophyll	Leaves soft, thin and pliant when folded, e.g. <i>Ocotea bullata</i> , <i>Clutia pulchella</i> , <i>Gnidia coriacea</i> , <i>Indigofera denudata</i>

TABLE 4.—Characters of herbaceous plants that were recorded

Height class (Fig. 4 and <0.1 m)	
Graminoid (excludes restioid-like geophytes, e.g. <i>Bobartia indica</i> and sedge-like geophytes, e.g. <i>Lanaria lanata</i> , but includes grass-like plants that are non-geophytic, e.g. <i>Caesia</i> (Liliaceae))	
Restioid (Restionaceae, wiry aphyllous)	
Plumose (tall restioids with feather-like terminal branches, e.g. <i>Restio rhodocoma</i> , <i>Cannomois virgata</i> , <i>Leptocarpus paniculatus</i>)	
Sprawling (fine stemmed restioids in which the stems are crawling or intermeshed and often flat-stemmed, e.g. <i>Anthochortus</i>)	
Hummocky (e.g. <i>Hypolaena crinalis</i>)	
Other	
Grass (mostly Poaceae)	
Annual	
Aphyllous (nearly leafless, hard-stemmed grasses, e.g. <i>Ehrharta ramosa</i>)	
Other	
Leaf texture	
Orthophyllous (e.g. <i>Themeda triandra</i>)	
Sclerophyllous (e.g. <i>Pentastichis eriostoma</i>)	
Leaf width	
Wide (>2 mm)	
Narrow (<2 mm)	
Growth form	
Hummocky (e.g. some <i>Danthonia stricta</i>)	
Other	
Sedge, cyperoid (Cyperaceae)	
Aphyllous	
Coarse (stems >1 mm in diameter, e.g. <i>Tetraria cuspidata</i>)	
Fine (<1 mm, e.g. <i>Ficinia filiformis</i>)	
Leafy	
Very wide leaves (leaves >20 mm wide, e.g. <i>Tetraria thermalis</i>)	
Wide leaves (5–20 mm, e.g. <i>Tetraria involucreta</i>)	
Narrow leaves (<5 mm, e.g. <i>Tetraria ustulata</i>)	
Fern	
Pinnate fern (1 or more times pinnate)	
<i>Pteridium aquilinum</i>	
Other	
<i>Schizaea</i> (a restioid-like fern)	
Geophyte	
Leaf deciduousity	
Evergreen (and semi-deciduous) (e.g. <i>Aristea</i> , <i>Corymbium</i> , <i>Watsonia</i>)	
Deciduous	
Leaf size and form	
Treter, Bobartioid (e.g. <i>Bobartia indica</i>)	
Parallel-veined	
Microphyllous (<2.025 mm ²)	
Meso-macrophyllous (>2.025 mm ²)	
Net-veined (most dicotyledonous geophytes)	
Forb	
Pubescence	
Pubescent (on both surfaces, e.g. <i>Helichrysum</i> spp.)	
Other (not pubescent or pubescent on only one surface)	

Leaf deciduousity
Evergreen
Deciduous
Growth-form
Annual
Climbing
Creeping
Erect
Rosette (e.g. <i>Villarsia ovata</i> , <i>Drosera</i> spp.)
Parasitic (e.g. <i>Cassytha</i>)

The proteoids have various characteristics which set them apart from most other fynbos species, and therefore permit them to be used in the classification. Firstly, in most fynbos vegetation it is impossible to pick out one or two dominant species. Many authors have noted the lack of single species dominance in fynbos (e.g. Bews, 1916; Taylor, 1978). This is not the case in Proteoid Fynbos where there is but a single (or perhaps two) important species in the canopy (Fig. 6). Secondly, most fynbos plants tend to have narrow distributions. This is generally not the case with the mid-high to tall proteoids that I have used as characters. These proteoids do not show the geographically complex (and perhaps ecologically meaningless) patterns (Campbell, 1985a) that are shown by most fynbos species. Thirdly, from a practical point of view, the Proteaceae have received much recent taxonomic treatment (Rourke, 1980; Williams, 1972) and, unlike many other taxonomic groups, are relatively easily identified even by the non-specialist, e.g. see work on *Protea* by Rourke (*l.c.*).

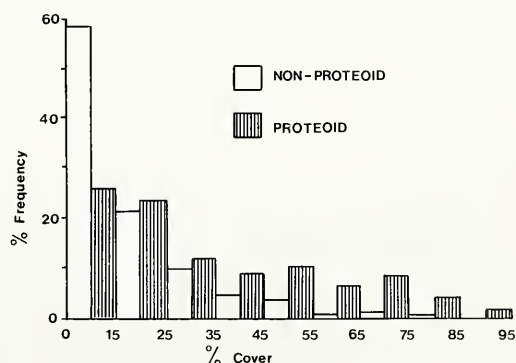


FIG. 6.—Dominance patterns shown by tall seed-regenerating dominant proteoids compared to the patterns shown by other fynbos dominants. The proteoid dominants generally have higher cover values than the other dominants (data for all the dominants that were recorded).

Chapter 5

Major vegetation groups

Four major vegetation categories, here termed groups, are recognized:

1. Forest & Thicket;
2. Karroid & Renoster Shrubland;
3. Grassland & Grassy Shrubland; and
4. Fynbos.

Less than 20% of the plots collected are classified in the non-fynbos groups and these plots represent diverse structural formations ranging from tall forest to low sparse succulent shrubland and to closed grassland. The non-fynbos communities are all minor constituents of the mountain vegetation.

Fig. 7 gives an overview of the entire classification and is also a reference to the chapters which contain the field identification keys to the communities. Table 5 shows the differentiating characters of the groups. Much of this chapter is extracted from Campbell (1985b).

Fynbos

Definition of fynbos

A complex operational definition of fynbos is encompassed in the key for distinguishing non-fynbos from fynbos (Table 6). As can be seen, a large number of vegetation features (characters in various character states) have been used in the key, but in essence a small subset of features can be used to distinguish most fynbos communities. For example, over 60% of the fynbos plots have >30% restioids and over 85% of the fynbos plots have >10% restioids. 98% of the fynbos plots are classified as fynbos by the key. The remaining fynbos plots should not strictly be included in the fynbos concept. They have usually been placed in fynbos because they show greater similarity to other fynbos plots than to non-fynbos. For instance, three Closed-Scrub (Riparian) Fynbos plots are not strictly fynbos, but rather than recognize a 'Riparian Thicket' in Forest & Thicket they are placed in Closed-Scrub Fynbos as they share many common features with Closed-Scrub Fynbos (e.g. microphyllous tall shrubs). Three plots in Grahamstown Grassy Fynbos are also keyed out as non-fynbos. They have extremely high ericaceous cover (>60%) but lack resti-

oids. They are typical examples of what I will later term Afromontane Fynbos, but it has been thought unnecessary to erect formally another major category for three plots.

From Table 6 it can be seen that the essential feature of fynbos is the presence of restioids, and that other important features are Ericaceae and proteoids. In addition, the following attributes are more or less differential: sedges, particularly leafy sedges; non-ericaceous ericoids (with >5% cover); ericoid Asteraceae; stoeboids; aphyllous grasses; leaf spinescence; Penaeaceae; and Bruniaceae.

The fynbos environment

Fynbos is essentially a vegetation linked to the distribution of T.M. and Witteberg quartzites. The soils derived from these quartzites are characterized by coarse-texture, low pH and low plant-nutrient status (Campbell, 1985b; Bond, 1981; Cowling, 1983). However, the link between quartzites and fynbos is not perfect. Where annual precipitation is less than 400 mm non-fynbos is found on quartzites, whereas where annual precipitation exceeds 700 mm fynbos can be found on non-quartzites. These patterns could be related to leaching and therefore to nutrient conditions, but the patterns could also possibly be related to soil-moisture conditions, with the non-quartzitic soils generally being more droughty. Without experimentation, it is almost impossible to separate the effects of nutrients and moisture (see Campbell 1985b, for further discussion).

Non-fynbos groups

The three non-fynbos groups represent diverse structural types and they share no features which are absent from fynbos. More or less restricted to non-fynbos (but also common in Grassy Fynbos) are nanophyllous shrubs with a relatively high cover (e.g. >5%). Deciduous shrubs and succulents are usually found with a higher cover or higher constancy in the non-fynbos groups. The three non-fynbos groups are distinguished in Key 1.

Forest & Thicket (Group F)

Differentiating features: Forest & Thicket is distinguished from other groups by a high cover of tall shrubs or

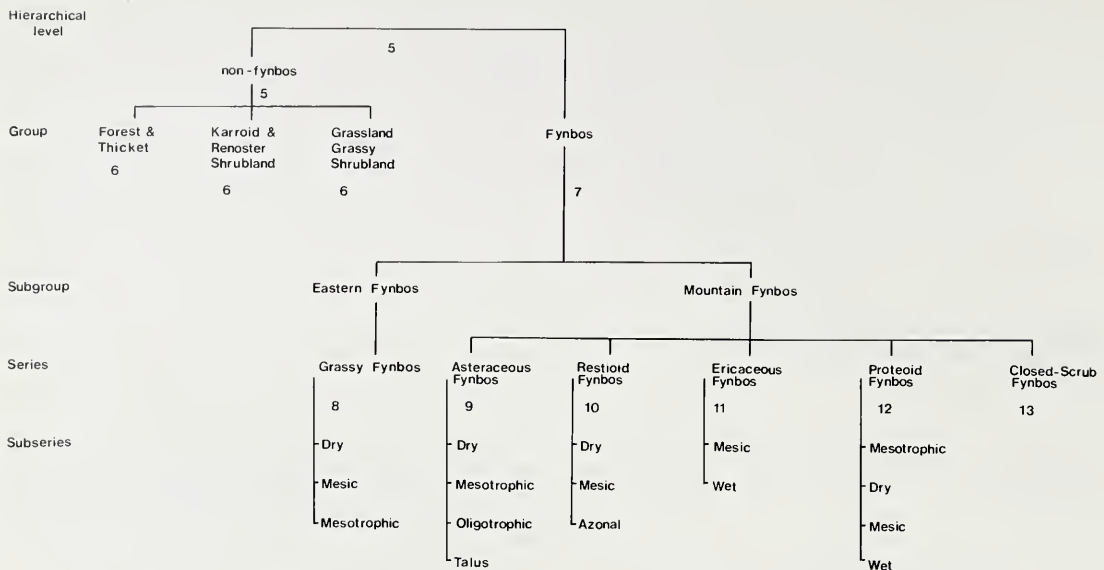


FIG. 7. —Hierarchical arrangement of the communities. Only the upper levels of the hierarchy are shown. The field keys for identifying communities are contained in the chapters enumerated in this figure.

KEY 1.—Key to the non-fynbos groups

1. >10% trees, or >10% non-proteoid tall microphyllous shrubs combined with <60% total cover Forest & Thicket (Key 2)
2. <20% grass, or if >20% grass then >30% elytopappoids, unless <30% total cover, >10% grass (Baviaanskloof Grassy Shrubland – Key 4) . . . Karroid & Renoster Shrubland (Key 3)
3. Succulents usually less than 5%, <10% microphylls, high relative cover of grasses Grassland & Grassy Shrubland (Key 4)

trees which have leaves other than leptophylls. Microphylls are the dominant leaf size with one series being mainly nanophyllous. Mesophylls may be present. Climbers and a high cover of stem spinescence are other characteristic features of Forest & Thicket. In one series there is a high cover of tall succulents (many of them stem succulents). Many orthophyllous shrubs are present. Orthophylls are not common in fynbos or in the other non-fynbos groups.

Distribution: Mostly the coastal mountains [SW, SC & E (see Fig. 5, here and in succeeding chapters, for explanation of mountain region abbreviations)].

Environment: Forest & Thicket is primarily a community of the better-developed soils (e.g. sandy clay loams, <25% rock cover, >0.75 m soil depth). This community shows a tendency to be found at low altitudes especially at the base of the southern and coastal mountains. Altitude *per se* is probably a factor complex exerting an indirect influence *via* correlated environmental factors: it is mostly at low altitudes that the better-developed soils are found. The southern and coastal distribution of Forest & Thicket reflects the moisture requirements of the constituent species (annual rainfall usually exceeding 700 mm, pan evaporation below 1 700 mm per year and greater than 50% rain in the non-winter nine months).

The analysis presented here is consistent with Cowling's (1984) findings regarding thicket (that is, excluding Afromontane Forest). He stresses edaphic controls on the distribution of thicket, suggesting that thicket is

restricted to deep and well-drained soils of moderately high fertility. Some fynbos types are a feature of deep soils but these soils are usually poorly drained, coarse-textured and low in pH and plant nutrients (e.g. soils of Azonal Restioid Fynbos and Wet Ericaceous Fynbos).

Karroid & Renoster Shrubland (Group K)

Differentiating features: The chief differentiating features of Karroid & Renoster Shrubland are low total cover, high succulent cover (or, in one series, high elytopappoid cover), and the presence of annual forbs, annual grasses, rosulate succulents and stem succulents. There is a high constancy of stem spinescence, a feature shared with Forest & Thicket.

Distribution: Mostly the interior mountains.

Environment: The environmental distinctions between fynbos and Karroid & Renoster Shrubland relate more to climatic than edaphic factors; Karroid & Renoster Shrubland is a feature of low-rainfall areas (below 600 mm p.a.). Such areas are especially common on the foothills of the interior mountains. In these areas, rainfall is sufficiently low for the non-fynbos shrublands to be able to occur on the T.M. quartzites. On the quartzites they are found particularly on hot north slopes (e.g. as on the Groot Swartberg and Swartuggens). On the south slopes, fynbos usually extends to the base of the quartzites and may even extend to the non-quartzites if rainfall is above 600 mm. Rock cover is usually higher in Karroid & Renoster Shrubland than in fynbos (70% *versus* 50% cover). The importance of soil in the 400–

TABLE 6. —Key to the fynbos/non-fynbos distinction. This table is the beginning of the key to all the recognized communities. References within such tables to other tables indicate the path that the user must take in keying out a community. The working of the key is explained in Chapter 3

Key characters	Fynbos communities included by the key characters	% of fynbos plots included by the key characters	Cumulative % of fynbos plots included by the key characters
Fynbos if one or more of the following 4 clauses are satisfied (See key p.42 for subdivisions of fynbos)			
>30% restioids unless >80% grass, <1% Ericaceae (Waterkloof Grassland — see key p.32)	Most fynbos excluding much of Asteraceous Fynbos, Mesotrophic Proteoid Fynbos and Grassy Fynbos	64	64
>10% restioids unless one of the following:			
<30% restioids, >50% non-proteoids >5 m (Afromontane Forest — on the ecotone to fynbos — see key p.24)			
<20% restioids, >40% non-proteoid microphylls, without plumose restioids (Mitchell Thicket — see key p.24)			
<20% restioids, >40% elytrapappoids, <1% Ericaceae, <5% proteoids (Renoster Shrubland — see key p.27)			
<30% restioids, >70% grass, <20% proteoids, <20% Ericaceae (mostly Hankey, Suurberg and Waterkloof Grasslands — see key p.32; also Engelseberg Grassy Fynbos — see key p.46)	Most fynbos excluding much of Wet Proteoid Fynbos, Mesotrophic Proteoid Fynbos and Grahamstown Grassy Fynbos	88	88
<20% restioids, >30% grass, <50% total cover (Seweweekspoort Grassy Shrubland — see key p.32)			
>1% restioids and one of the following:			
>5% proteoids, <40% grass and other fynbos elements present, e.g. ericoids, stoeboids			
<70% total cover, <20% grass: unless >30% non-proteoid microphylls >1,5 m, no plumose restioids (Mitchell Thicket — see key p.24)	Mostly Proteoid Fynbos	45	93
or unless >10% succulents, >5% fleshy-leaved shrubs, elytrapappoids present	Mostly Asteraceous Fynbos, Dry Restioid Fynbos and Trident Azonal Restioid Fynbos	21	96
>20% Ericaceae, <40% grass, <20% non-proteoids >5 m			
>40% proteoids	All types of Fynbos	28	97
plumose restioids present, unless >50% non-proteoids >5 m	Proteoid Fynbos	13	98
≥0% restioids and one of the following	Especially to accommodate Closed-Scrub Fynbos	No data available — key characters added when testing the classification	
>40% ericoids, <10% grass, <70% total cover			
<10% grass <40% of one of the following: Bruniaceae, Penaeaceae, proteoids	Especially to accommodate Asteraceous Fynbos		
Non-fynbos (see key p.18)	Especially to accommodate various peculiar fynbos types		

600 mm annual rainfall regime has already been mentioned: fynbos gives way to Karroid & Renoster Shrubland on the fine-textured soils.

Grassland & Grassy Shrubland (Group S)

Differentiating features: Grassland & Grassy Shrubland is primarily distinguished by the high cover of grass, although in one series there is lower cover of grass combined with a very low total cover. A number of features not found in other non-fynbos groups link Grassland & Grassy Shrubland with fynbos, e.g. pubescent forbs, rosette forbs, bobartoid geophytes and a high constancy of Ericaceae, restioids and proteoids. Although Grassland & Grassy Shrubland often possesses many characteristic fynbos features (e.g. restioids), it never occurs with a high cover.

Distribution: E.

Environment: Grassland & Grassy Shrubland generally occurs in areas with higher summer rainfall, lower annual rainfall, lower altitudes and finer-textured soils than most fynbos. In the east, where both fynbos (Grassy Fynbos) and Grassland & Grassy Shrubland occur, the latter group is found under drier (and less leached) conditions (e.g. on more northerly slopes, or in more interior mountains). In the east, fynbos gives way to the non-fynbos grass communities at annual precipitations between 500–800 mm. Where annual precipitation exceeds 800 mm, it is only fynbos that is found and below 500 mm it is usually Grassland & Grassy Shrubland that is found, with Karroid & Renoster Shrubland at even lower rainfall. The non-fynbos communities of the east (grassy communities) extend to higher rainfall areas than the non-fynbos communities of the west (Karroid communities). This probably occurs because the quartzites of the east are finer textured, giving rise to finer-textured soils.

Discussion

Relationships between non-fynbos groups and fynbos series

A number of fynbos series have close links with the non-fynbos groups. These links are more fully explored in later sections, but are briefly mentioned here. Forest & Thicket, with its high cover of dorsiventral microphylls and orthophylls, and its high stature is very similar to certain types of Closed-Scrub Fynbos. Asteraceous Fynbos shares many features with Karroid & Renoster Shrubland (e.g. low cover, elytopappoids, succulents, fleshy-leaved shrubs, and non-ericaceous ericoids). Asteraceous Fynbos also shows similarities with Grassland & Grassy Shrubland, but it lacks the high grass

cover of Grassland & Grassy Shrubland. Grassland & Grassy Shrubland is especially close to Grassy Fynbos.

Previous concepts of fynbos

The term fynbos has previously been used in two very different ways. Bews (1925), who probably introduced the term to botanical literature, applied it to the fine-leaved shrublands of the study area and to those of the Drakensberg and Eastern Cape. The terms fynbos or macchia have been subsequently used, by many botanists, to encompass all these shrublands (see references in Campbell, 1985b). On the other hand, other botanists (e.g. Kruger, 1979a; Taylor, 1978) use fynbos to denote only those shrublands of the present study area. I have continued with the former tradition. Following Moll *et al.* (1984) and Cowling (1984), I recognize two major categories of fynbos: Cape Fynbos (essentially a restionaceous understorey, but including Grassy Fynbos — see Chapter 7) and Afromontane Fynbos (essentially a grassy non-restionaceous understorey). The definition proposed here for fynbos (encompassed in Table 6) is specifically for Cape Fynbos as very few plots could be regarded as Afromontane Fynbos. Killick (1979) provides a recent review of Afromontane Fynbos. It is fine-leaved shrubland (Ericaceae, *Passerina* spp., *Cliffortia* spp.) with an understorey of grass, and it usually lacks or has a very low cover of restioids. Grassy Fynbos occurs on the ecotone between Afromontane Fynbos and Cape Fynbos, but is placed in the latter group because of the presence of restioids.

Previous definitions of fynbos have revolved around the so-called lack of single-species dominance and the characteristic presence of restioid, proteoid and ericoid elements (Taylor, 1978; Kruger 1979a). Kruger (1979a) has suggested that restioids are the only constant and differential floristic elements. The idea of lack of single-species dominance has been rejected and no single element is sufficient to define fynbos (Cowling, 1984; Campbell, 1985b). Therefore, I have resorted to a complex polythetic definition. Restioids are most important in this definition, but also playing a large role are Ericaceae, proteoids and low cover of grass. Bond (1981) notes the restriction of leaf spinescence to fynbos. This is an important differentiating feature. In a discriminant function, it follows restioids, sedges and proteoids in importance in differentiating fynbos from non-fynbos (Campbell, 1985b).

It should be noted that 'fynbos' is not seen as a synonym for 'heathland' and I restrict the term heathland to one of the series of fynbos (Ericaceous Fynbos) (see Campbell, 1985b, for further discussion).

Chapter 6

Non-fynbos communities

In this chapter, the three major vegetation groups of non-fynbos communities are discussed. These are as follows.

1. Forest & Thicket;
2. Karroid & Renoster Shrubland; and
3. Grassland & Grassy Shrubland.

The mutual relationships between these three major vegetation groups and with Fynbos have been outlined in their general context in Chapter 5 (see Fig. 7, Table 5 and Key 1). The broad classification of the three major groups of non-fynbos communities as treated in this chapter is set out in Table 7.

Forest & Thicket (Group F) (Table 8 and Key 2)

Afromontane Forest

Stratification: 76, 78, occasionally 66, 56 (see Fig. 4 here and wherever stratification is mentioned under communities to follow).

Formation: Low or tall, microphyllous, evergreen forest usually with a sparse ground layer (see Table 1 here and wherever formation is mentioned under communities to follow).

Differentiating features: The two series in Forest & Thicket that include forest formations, Afromontane Forest and Eastern Forest & Thicket, are differentiated from each other by the former generally having a higher cover of taller trees, and by the latter having a higher cover of climbers and spinescence, and a better-developed ground layer. Afromontane Forest, unlike Eastern Forest & Thicket, very rarely includes a closed shrubland within its range of structure. Ferns are more a feature of Afromontane Forest than Eastern Forest & Thicket. These two series share a number of characters that are lacking in the other series of Forest & Thicket, namely a high cover of microphylls and mesophylls and the presence of wide leafy sedges in the ground layer. The ecotone between Afromontane Forest and Fynbos is normally abrupt owing to the effect of fires that burn to the edge of the forest. However, one occasionally

finds forest that includes fynbos elements such as Ericaceae and restioids (Plots 329, 281). Forest trees also extend into some fynbos communities, e.g. *Cunonia capensis* in some Wet Proteoid Fynbos.

Floristics: Table 9 records the dominants of Afromontane Forest and Eastern Forest & Thicket and indicates that the two series can be differentiated on floristic grounds. Afromontane Forest, as the name implies, contains a high percentage of Afromontane phytochorological elements, whereas Eastern Forest & Thicket comprises species which are mostly linked to the more lowland forests (Tongaland-Pondoland species) (see Cowling, 1984).

Distribution: Afromontane Forest is essentially a feature of the coastal mountains (SW & SC — Fig. 8).

Environment: Afromontane Forest is restricted to the more mesic environments in the mountains, being found in sheltered valleys often near streams. It is sometimes found on soils which are similar in texture and chemistry to those of fynbos but in these cases it is restricted to sites which have year-round moisture and which are protected from fire and are probably sheltered from strong winds. More than half of the 507 plots of the present study are above 1 000 m elevation and yet it is rare to find non-fynbos above 700 m, the occasional exception being plots representing Afromontane Forest. Despite the presence of Afromontane Forest on shallow T.M. quartzites, it is more often the case that this community is found on deeper soils (e.g. granite soils, colluvium and alluvium). Walter (1973) and Acocks (1953 & 1975) suggest that fire and logging have resulted in a great reduction in the amount of Afromontane Forest on the mountains. However, Campbell & Moll's (1977) reconstruction of the distribution of forest on Table Mountain, would suggest that forest has always been restricted to rather localized environments and that it was never widespread in the mountains.

Synonymy: Phytosociological accounts of Afromontane Forest can be found in Boucher (1978), Campbell & Moll (1977), Cowling (1984), McKenzie (1978) and Werger *et al.* (1972). Phillips (1931) has provided a detailed descriptive account of the Afromontane Forest found in the Knysna area.

TABLE 7.—The non-fynbos communities of the mountains of the Fynbos Biome. Those communities not marked with an asterisk are not typical of the mountains. Unlike the other communities, they are not named after localities in the Biome and, with further syntaxonomic study, they will probably be much subdivided. The communities typical of the mountains (with asterisks) are given alphanumeric codes

Groups	Forest & Thicket (Group F)	Karroid & Renoster Shrubland (Group K)	Grassland & Grassy Shrubland (Group S)
Series	Afromontane Forest	Tall Succulent Shrubland	* Baviaanskloof Grassy Shrubland (S1)
	Eastern Forest & Thicket	Succulent Shrubland	* Bosrug Grassy Shrubland (S2)
	Kaffrarian Succulent Thicket	* Clanwilliam Karroid Shrubland (K1)	* Seweweekspoort Grassy Shrubland (S3)
	Cape Thicket	Renoster Shrubland	* Hankey Grassland (S4)
	* Mitchell Thicket (F1)		* Elandsberg Grassy Shrubland (S5)
			* Suurberg Grassland (S6)
			* Waterkloof Grassland (S7)

KEY 2.—Key to the series of Forest & Thicket

1. >40% climbers or >40% stem spinescence
 - 1.1 >60% stem spinescence, >20% deciduous shrubs Kaffrarian Succulent Thicket
 - 1.2 >40% climbers, >10% cover in the 0–0,25 m height class Eastern Forest & Thicket
2. >10% cover (usually >40%) in the 5–10 m height class and usually without rosulate succulents Afromontane Forest
3. Usually <80% total cover, habitat distinctive: coarse loose screes Mitchell Thicket
4. Often present: >5% stoebooids, elytropappoids, ericoid Asteraceae, *Pteridium aquilinum* Cape Thicket

Eastern Forest & Thicket

Stratification: 62 to 78.

Formation: Low forest or tall, closed shrubland (microphyllous and evergreen) with a sparse to open ground layer (Fig. 9).

Differentiating features: Eastern Forest & Thicket is differentiated by the high cover of climbers, and the relatively well-developed herbaceous ground layer that has leafy sedges and forbs. Stem spinescence is much higher than in Afromontane Forest.

Floristics: See Table 9.

Distribution: The important environmental differences between Afromontane Forest and Eastern Forest & Thicket (e.g. the summer-rainfall climate in the latter) relate to the eastern distribution of Eastern Forest & Thicket (E — Fig. 8).

Environment: Eastern Forest & Thicket, like Afromontane Forest, is restricted to the less exposed, more mesic sites in the mountains, often on southerly aspects or on valley floors. Fire protection also appears to be important. Soils are deep and well-drained (often of the Hutton Form), and, relative to Afromontane Forest, are often finer-textured. Rainfall in Eastern Forest & Thicket is usually above 600 mm.

Synonymy: Cowling's (1984) *Pterocelastrus tricuspidatus*–*Euclea undulata* Kromme River Thicket and *Pterocelastrus tricuspidatus*–*Gonioma kamassi* Knysna Thicket Communities are examples of Eastern Forest & Thicket. Cowling's work is the only phytosociological account of Eastern Forest & Thicket. This gives extensive references to previous descriptive treatments and indicates the many veld types (*sensu* Acocks, 1953 & 1975) that contain communities of Eastern Forest & Thicket.

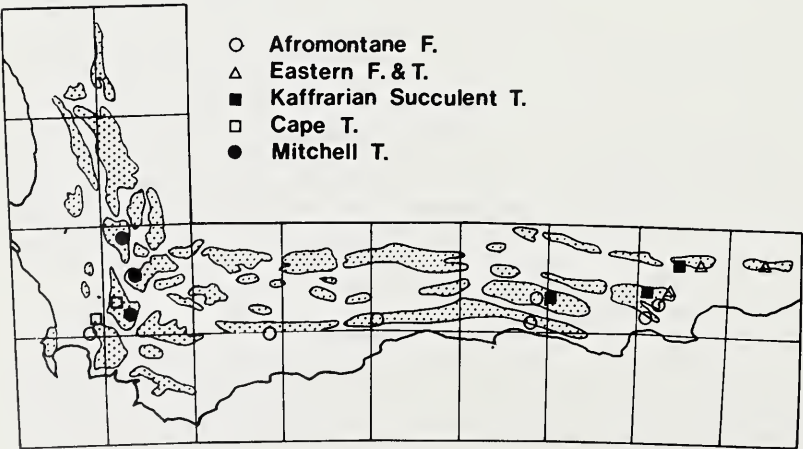


FIG. 8.—Distribution of Forest & Thicket.

TABLE 8.—Differentiated table for Forest & Thicket. Notes on the characters and conventions used in the differentiated tables (for further details on characters see Chapter 4):

- (1) † = woody plants; # = woody and herbaceous plants; 'no symbol' = herbaceous plants.
- (2) Leaf sizes refer to evergreen non-succulent woody plants unless otherwise indicated. Lobed-leaved plants were not included in the leaf size determinations. Leaf textures and leaf forms refer to evergreen woody plants unless otherwise indicated.
- (3) Proteoids were always recorded as evergreen sclerophylls and they have not been included under pubescence. Deciduous, semi-succulent or succulent plants were also not included in the determination of pubescence.
- (4) *Protea nitida*, usually mesophyllous, is not included in the leaf size subdivisions for proteoids.
- (5) 'Grass' and 'Forb' refers to perennials, unless otherwise indicated.
- (6) The values in the table are cover values unless otherwise indicated. The cover scale used is as follows:
+ = less than 1% cover; * = 1–5%; 0 = 5–10%; 1 = 10–20%; 2 = 20–30%; 3 = 30–40%; 4 = 40–50%; 5 = 50–60%; 6 = 60–70%; 7 = 70–80%; 8 = 80–90%; 9 = greater than 90%.
- (7) In many cases only certain character states are shown, e.g. only plots with >20% cover of deciduous shrubs are shown for '† Deciduous >1'.

	Afromontane Forest								Eastern Forest & Thicket			Kaffrarian Succulent Thicket		Cape Thicket			Mitchell Thicket		
	Plot numbers																		
	329	281	186	391	342	405	189	249	364	378	372	408	255	183	182	013	003	046	074
† Total cover, 5–10 m	8	2	8	7	3	6	5	1	8			*					*		
† Total cover, 10–20 m			1	3	3	9			3										
Grass, aphyllous >4	6																		
† Ericaceae	*	5												+					
Restioid >1	2																		
# Climber >1									4	4	5	5							
# Total cover, <0,25 m >0									1	2	1								
Sedge, leafy (wide) >*									0	0	0								
Geophyte, evergreen >*									0	0									
Forb (non-pubescent) >1										9									
† Microphyllous, non-proteoid >8			9	9	9	9	9	9	9	9	9					9			
† Mesophyllous, non-proteoid		2	2	*	6			*	1	2	*	*					*		
Sedge, leafy (wide)				*	+	*			0	*	0								
† Spinescence, stem >4												8	7						
† Deciduous >1												2	6	2					
† Succulent, stem												1	*						
† Succulent, >1 m												2	+				*		
# Total cover, 2–5 m >7						8	8		9	9		9	8						
† Nanophyllous, non-proteoid, >1,5 m >1	9	2								4		9	3						
† Spinescence, stem >0				1		2	3		3	4	2	8	7						
# Climber >0						1	1	1	4	4	5	5	1						
† Elytropappoid														*		0			
† Pubescent-leaved	*	*										*		1	1		*	*	
† Proteoid, nanophyllous, <1,5 m (non-mat)														*	*				
† Stoebeoid														1	0		*	*	
† Ericoid-leaved (Asteraceae)														*	*				
† Fleshy-leaved												*		*		1			
† Woody plant, non-proteoid >7	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9			
# Total cover >7	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9			
Grass, aphyllous	6							0									*	*	*
† Succulent, rosulate							+					+					*	*	*
Sedge, aphyllous, coarse				*										*			*	*	*
† Leptophyllous >0		5						1						3	2		2	1	1
† Spinescence, leaves															1		0	0	
Climber, parasitic forb														0	*		*		
† Woody plant, 1–1,5 m >0												1	1		1	1	2	1	
† Woody plant, 0,25–0,5 m >*	0							0				0		2	0	0	0		
† Nanophyllous, non-proteoid, <1,5 m >*												1	1	0	1	0	0	1	
† Deciduous								0		*		2	6	2	*	*	*		
† Woody plant, 0,5–1 m >*									0	0	0	0	1	3	2	1	0	0	
# Total cover, 0,5–1 m >*	6	1			1				0	0	0	0	1	3	3	1	0	0	1
# Total cover, 1–1,5 m >*	0							1			0	1	1	0	2	1	2	1	
Graminoid, <0,1 m									*					*	*	*	*	*	*
Fern, pinnate-leaved	*	0	*	+	2		+	*							2		+	+	*
Sedge, aphyllous	*	0		*										*			*	*	*
Graminoid, relative cover >*	4	0	1				0		0	0	0	1		0			0	1	0

TABLE 9.—Dominant species occurring in two or more plots of Afromontane Forest or Eastern Forest & Thicket. *Podocarpus falcata*, *P. latifolius* and *P. elongatus* have been lumped together. The cover values shown are as follows: 1 = 10–20% ; 2 = 20–30% ; 3 = 30–40% ; 4 = 40–50% ; 5 = 50–60% ; 6 = 60–70% ; 7 = 70–80% ; 8 = 80–90%

	Afromontane Forest								Eastern Forest & Thicket			
	Plot numbers											
	329	281	186	189	391	405	249	342	378	372	364	
<i>Halleria lucida</i>		2	2				1					
<i>Podocarpus</i> spp.			2	3	2							
<i>Maytenus acuminata</i>					2	1	2					
<i>Virgilia oroboides</i>	8	1										
<i>Secamone alpinii</i>				1	2							
<i>Rapanea melanophloeos</i>			2					1				
<i>Pterocelastrus tricuspidatus</i>					3		4					
<i>Linociera foveolata</i>					1	2						
<i>Smelophyllum capense</i>					1	1						
<i>Scutia myrtina</i>								2	2	5		
<i>Cassine aethiopica</i>										2	4	
<i>Schotia latifolia</i>										2	1	
<i>Myrsine africana</i>						1						2

Kaffrarian Succulent Thicket

Stratification: 63, 66.

Formation: Tall, closed, nanophyllous shrubland (Fig. 12).

Differentiating features: Kaffrarian Succulent Thicket, although only represented by two plots in the present study, is extremely distinctive with its tall succulents (including stem succulents) and very high cover of stem-spinescent shrubs (>70%). Unlike the previous series, it is largely nanophyllous rather than microphyllous, and unlike any other series of Forest & Thicket, it has a very high cover of deciduous species (e.g. *Rhus longispina*). Ferns and sedges are absent.

Floristics: Kaffrarian Succulent Thicket appears to be floristically similar to Eastern Forest & Thicket. Dominant species in common include *Scutia myrtina*, *Euclea undulata*, *Rhoicissus digitata* and *Cussonia spicata*. On the ecotone between Kaffrarian Succulent Thicket and Fynbos (e.g. as on Enon conglomerates), ericoid elements such as *Passerina* occur within the otherwise thicket vegetation.

Distribution: This series is an eastern community (E—Fig. 8). Kaffrarian Succulent Thicket usually occurs in extensive contiguous areas. However, some bush clumps can also be included in the concept of Kaffrarian Succulent Thicket (Fig. 12).

Environment: Whereas Eastern Forest & Thicket often occurs on mountain soils derived from quartzites, Kaffrarian Succulent Thicket is a feature of fine-textured soils (e.g. shale-derived soils). Relative to Eastern Forest

& Thicket it occupies more xeric situations (e.g. often with an annual rainfall below 600 mm). Soils are deep, and mostly of the Hutton and Swartland Forms.

Synonymy: The concept of Kaffrarian Succulent Thicket is identical with Cowling's (1984) concept of Kaffrarian Succulent Thicket. The latter work is the only phytosociological account available. Much of the climax vegetation of Acocks's (1953 & 1975) Valley Bushveld would be included in the present concept.

Cape Thicket

Stratification: 43, 65, 66.

Formation: Mid-high to tall, closed, evergreen, microphyllous shrubland.

Differentiating features: There are few good differentiating characters for Cape Thicket. Characteristic, but low in cover and constancy, are elytropappoids, stoeboids, ericoid-leaved Asteraceae, fleshy-leaved shrubs and nanophyllous proteoids. Cover of pubescent shrubs is often high. The differentiating features of the previous three series are lacking, notably trees and a high cover of climbers and stem-spinescent shrubs. Leaf spinescence may be high and deciduousity may occasionally be high (e.g. 20% cover of *Montinia caryophyllacea*).

Floristics: *Rhus angustifolia*, *Anthospermum aethiopicum*, *Olea europaea* subsp. *africana*, *Chrysanthemoides monilifera*, *Pteridium aquilinum*, *Montinia caryophyllacea*, *Helichrysum crispum*, *Stoebe plumosa* and *Diospyros glabra*.

Distribution: SW & C (Fig. 8).

Environment: Cape Thicket occupies more xeric sites than Afromontane Forest (e.g. on more exposed slopes). Soils are deep, fine-grained (e.g. granite-derived) and often of the Hutton Form. Cape Thicket may occasionally be found as bush clumps in areas dominated by fynbos (e.g. as in granite areas with 1400 mm rainfall) with the bush clumps being associated with termitaria or rocky sites protected from fire.

Synonymy: No detailed accounts of Cape Thicket have been published. The following previously described communities could best be placed in Cape Thicket: Grobler & Marais's (1967) '*Olea-Buddleja* Community' (= '*Olea-Chilianthus-gemeenskap*') from the lowlands near the Langeberg transect; Acocks's (1953 & 1975) woody scrub dominated by *Olea europaea* subsp. *africana* and *Sideroxylon inerme* in his Renosterveld veld type; and Moffett & Deacon's (1977) Mixed Bush (*Rhus lucida*, *Maytenus oleoides*, *Rhus undulata* and *Tarchonanthus camphoratus*).

Mitchell Thicket (Series F1)

Stratification: 63, 66, 67.

Formation: Mid-high to tall, open, evergreen, microphyllous shrubland.

FIG. 9.—Eastern Forest & Thicket. The abrupt ecotone between the thicket and the grassland (Suurberg Grassland) is related to fire. The thicket species include *Diospyros whyteana*, *Diospyros villosa*, *Maytenus heterophylla* and *Scutia myrtina*. Near Grahamstown, c. 800 m.



Differentiating features: Mitchell Thicket has no good differentiating characters but, unlike all the previous series, it is relatively open with less than 70% total cover, the gaps in the canopy usually being filled by extremely large boulders. Characters shared with Cape Thicket include pubescent shrubs, stoeboids, leaf-spinescent shrubs, parasitic climbing forbs and >10% leptophylls. Mitchell Thicket, Cape Thicket and Kaffrarian Succulent Thicket all have a high cover of nanophylls but it is only Kaffrarian Succulent Thicket which is dominated by nanophylls, the other thicket types being predominantly microphyllous. Aphyllous grasses and, to a lesser extent, rosulate succulents appear to be characteristic of Mitchell Thicket, and ferns are common to Mitchell Thicket and Afromontane Forest. Ferns were also recorded in one plot of Cape Thicket, but in this particular case the fern was *Pteridium aquilinum*, a fern that has a very different ecology from the mesophytic ferns of Mitchell Thicket and Afromontane Forest.

Floristics: In floristic terms, Mitchell Thicket is closer to Afromontane Forest than to any of the other Forest & Thicket series. Species in common include *Hartogiella* (= *Hartogia*) *schinoides*, *Heeria argentea* and *Maytenus oleoides*. Other dominants include: *Dodonaea viscosa*, *Olea europaea* subsp. *africana*, *Rhus undulata*, *Asparagus aethiopicus*, *Rhus lucida*, *Restio gaudichaudianus* and *Cliffortia ruscifolia*.

Distribution: NW, C & SW (Fig. 8).

Environment: Of the series of Forest & Thicket, this is the only series that is confined to the mountains. It never forms extensive stands and is restricted to screes within landscapes that are dominated by fynbos. The important environmental feature of Mitchell Thicket is the high cover of very large rocks (e.g. >1.0 m in diameter). This feature renders the community free from fire, unlike the fire-prone fynbos which surrounds the stands of Mitchell Thicket. Soil depths are shallow, but the plants probably have their roots in deep cracks. When the screes occur under high-precipitation conditions, e.g. as on Table Mountain, then the scree communities often reach the stature of forest (see Campbell & Moll, 1977; Werger *et al.*, 1972) and should be classified as Afromontane Forest.

Synonymy: Werger *et al.* (1972) provide the only phytosociological account of Mitchell Thicket. However, their community, the *Heeria argentea* Community, could be classed as Afromontane Forest rather than as tall shrubland.

Karroid & Renoster Shrubland (Group K) (Table 10 and Key 3)

Tall Succulent Shrubland

Stratification: 43.

Formation: Mid-high to tall, open, succulent and nanophyllous shrubland.

KEY 3.—Key to the series of Karroid & Renoster Shrubland

1. >5% succulents and, >10% nanophylls or >10% cover above 1.5 m,
unless >20% elytropappoids (Renoster Shrubland) or unless >5% ericoids (Clanwilliam Karroid Shrubland) **Tall Succulent Shrubland**
2. <20% succulents and, >5% ericoids or restioids present or >5% nanophylls,
unless >10% elytropappoids (Renoster Shrubland) **Clanwilliam Karroid Shrubland**
3. >10% elytropappoids, >30% leptophylls, usually >50% total cover **Renoster Shrubland**
4. Usually: >5% succulents, <40% total cover, <5% elytropappoids **Succulent Shrubland**

TABLE 10.—Differentiated table for Karroid & Renoster Shrubland. See Table 8 for notes on characters and conventions used

	Tall Succulent Shrubland									Succulent Shrubland					Clanwilliam Karroid Shrubland					Renoster Shrubland							
	Plot numbers																										
	461	419	460	204	246	206	238	435	339	153	160	106	128	118	108	161	216	129	107	205	163	254	211	347	232	070	266
† Nanophyllous, non-proteoid >0	1	2	1		2	1	2	1	1							1	1						1				
# Total cover, 1.5–2 m >*	1	1	0	1	1	1	1	0							1	1											
† Nanophyllous, non-proteoid, >1.5 m	0	*	1	*	2	1	2	0	*		*					1	1										
# Total cover, 2–5 m	1	0	0		0	0	2				*						*										
† Succulent, >1 m	2	2	*	1	0		0				*											+	1				
* Succulent, relative cover >2	6	5	4	3	3						5									3							
# Succulent >1	3	3		3							3																
# Climber		*		+	*		1	+							*												
† Succulent, rosulate	*		*		*	*					*					*				+		+					
Grass, annual											+	1	*		0												
Forb, erect												+	+	+												+	
Grass, aphyllous														+	0	*	*	*	+								
† Lobed-leaved, non-proteoid		+												0	+	*	*	1								0	
† Fleshy-leaved >0							1					1	1				1	2									
† Nanophyllous, non-proteoid >*	1	2	1		2	1	2	1	1						0	0	1		0				1				
† Nanophyllous, non-proteoid, <1.5 m >*	0	2			0	0		0	1						0	0		0					1				
Grass, 0.5–1 m					*		0								0		*	+									
† Spinescence, stem >*				0	0	3									0			+									
Fern, pinnate-leaved		+	*				+								0			0		+							
† Deciduous >*				0	0	1	0				0	0			1				0								
† Leptophyllous >2										3											3	6	4	6	9	8	4
† Elytrophappoid							0									+			0		1	3	1	1	7	4	3
† Orthophyllous >1										3												3	2	3	6	3	
# Total cover >5					6																		6	7	8	7	8
† Pubescent-leaved >*										2								0			1	3	2		0		
# Total cover, 1–1.5 m >2																						5	4	8		3	
† Woody plant, non-proteoid >8																							9	9			
Sedge, aphyllous, coarse																							*	+		*	
Grass >2																										3	6
† Ericoid-leaved (Rhamn-, Thymelae- & Asteraceae) >*															0		1	0	1			0		1			
Restioid															+				+	+			+		0	*	
† Aphyllous							*								*				+	+		*		*		+	*
† Aphyllous, yellow-stemmed							*												+	+				+	+	+	
† Leptophyllous >0							1	2		3	1		2	1	2	1	2	2	2	1	3	6	4	6	9	8	4
† Woody plant, 0.5–1 m >0	1			1		2	1			2	2		2		1	1	1	1			1	4		1	4	5	2
† Leptophyllous, broad (non-fleshy)					*	*	0	*		3	0	+	+		*	+	+		*		1	3	2	*	6		
† Pubescent-leaved		+			*	*	*	*		2	*	*				+	+	0			1	3	2	*	*	0	*
† Woody plant, 0.25–0.5 m >0				1		1				1	1				1	1	2		1		1	1		1	4	2	
Geophyte, deciduous						+	1			+	+	1			*	+			1		*	+	*		+		
† Succulent, stem				*		0				0	*	*	+	+		+			+	+	+	*					
Grass, <0.1 m						*	*				+	1	*					+	*			*				3	
Sedge, aphyllous													*	+						+				*	+	*	
† Microphyllous, non-proteoid	*	*		*	*	*	0													+		*	*	*	*	0	
Grass	*		*	1	0		1	*							+	0	*	*	*	1	*	0	1	+	*	3	6
† Ericoid-leaved (Rhamn-, Thymelae- & Asteraceae)			*		*		*	*							0	*	1	0	1	*		0		1	*		
# Total cover >3	5	4		6		4	4	4							4	4		4			5	6	7	8	7	8	

† = woody plants; # = woody and herbaceous plants; 'no symbol' = herbaceous plants; + = less than 1% cover; * = 1–5%; 0 = 5–10%; 1 = 10–20%; 2 = 20–30%; 3 = 30–40%; 4 = 40–50%; 5 = 50–60%; 6 = 60–70%; 7 = 70–80%; 8 = 80–90%; 9 = greater than 90%.

Differentiating features: All the series of the Karroid & Renoster Group have a high degree of succulence, but it is Tall Succulent Shrubland that is particularly succulent with up to 60% relative cover of succulent shrubs. Furthermore, the succulents are in many cases over 1 m (e.g. *Portulacaria afra*, *Crassula rupestris*). Tall Succulent Shrubland is clearly differentiated from the other series by a number of distinctive characters, apart from degree of succulence. It has a high cover of nanophyllous shrubs and is the only series with tall nanophyllous shrubs and a considerable amount of cover above 1.5 m in height. Unlike other series, leptophylls are not an important constituent. Climbers and rosulate succulents are fairly characteristic of Tall Succulent Thicket. It appears that two subdivisions of this series can be recognized on the basis of floristics: (1) *Portulacaria* Tall Succulent Shrubland, in which *P. afra* has over 20% cover, and (2) *Rhus*–*Crassula* Tall Succulent Shrubland, in which the tall succulent is usually *Crassula rupestris*.

Floristics: *Crassula rupestris*, *Portulacaria afra*, *Euclea undulata*, *Rhus glauca*, *Pappea capensis*, *Grewia robusta*, *Dodonaea viscosa* and other *Crassula* spp.

Distribution: SI (Fig. 10).

Environment: This series is found on the lower slopes of the interior mountains and is more extensive on the north aspects. It is usually found on non-quartzitic soils, but can occur on quartzites when under very xeric conditions [e.g. steep north slopes, or very low rainfall (<300 mm) on north aspects]. The soils are usually fine-textured and deep, and range from Mispah to Hutton Forms.

Synonymy: Bond's (1981) *Crassula rupestris*–*Digitaria natalensis* Community falls within Tall Succulent Shrubland. No other phytosociological accounts exist, but Acocks (1953 & 1975) provides a relatively detailed description of Spekboomveld, and much of this belongs to Tall Succulent Shrubland.

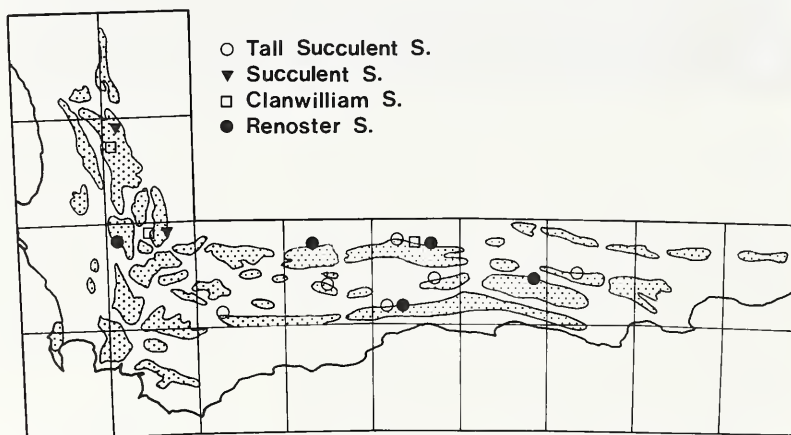


FIG. 10.—Distribution of Karroid & Renoster Shrubland.

Succulent Shrubland

Stratification: Mainly 32, but also 21 to 43.

Formation: Low, open to sparse, succulent and leptophyllous shrubland (Fig. 11).

Differentiating features: A number of characters link Succulent Shrubland, Clanwilliam Karroid Shrubland and Renoster Shrubland, but are generally absent from Tall Succulent Shrubland. These include low stature (<1.5 m), high cover of leptophylls, relatively high constancy of pubescent shrubs, and presence of deciduous geophytes, stem succulents and aphyllous sedges. There are few characteristic features occurring only in Succulent Shrubland. Erect forbs and annual grasses are more constant in Succulent Shrubland and total cover is lower. Unlike the other series of Karroid & Renoster Shrubland, Succulent Shrubland generally lacks perennial grasses and ericoid-leaved shrubs.

Floristics: Very variable — *Pteronia incana*, *Relbania squarrosa*, *Tylecodon wallichii*, *Eberlanzia* spp., *Lasiosiphon deserticola*, *Euphorbia mauritanica* (and other *Euphorbia* spp.), *Indigofera spinescens*, *Eriocephalus africanus* and *Crassula* spp.

Distribution: I & NW (Fig. 10).

Environment: Acocks (1953 & 1975) indicates that most Succulent Shrubland occurs in the dry non-mountain areas on soils not derived from T.M. or Witteberg quartzites. However, occasionally Succulent Shrubland is found on quartzites (e.g. where slopes are northerly and rainfall is low) and it can occasionally be found on high mountains (e.g. on the shalebands in the Swarttruggens at 1300 m). Soils can be deep or shallow (the shallow soils usually being quartzite-derived). Soils range from Mispah to Swartland Forms.

Synonymy: A great diversity of Succulent Shrubland occurs adjacent to the Fynbos Biome usually at the base of the interior mountains. Six of Acocks's (1953 & 1975) veld types occurring adjacent to the Biome would be included under Succulent Shrubland. Joubert (1968) and Olivier (1966) provide relatively detailed accounts of Succulent Shrubland in the Worcester-Robertson area, and some phytosociological data for Succulent Shrubland have been presented by Milton (1978).

Clanwilliam Karroid Shrubland (Series K1)

Stratification: 32 to 43.



FIG. 11.—Succulent Shrubland on T.M. quartzites. In the background, Bokkeveld geological formations can be seen and these would predictably also be covered by Succulent Shrubland. Shrubs of the foreground include *Relhania* sp., *Pteronia fasciata*, *Ruschia* sp. and *Gnidia deserticola*. 2 km from this plot, at a slightly higher altitude on the T.M. quartzites, restioids and ericoids are found (Clanwilliam Karroid Shrubland). Matjiesrivier, Cedarberg, c. 700 m.

Formation: Low to mid-high, open, leptophyllous (ericoid or fleshy) shrubland.

Differentiating features: Clanwilliam Karroid Shrubland and, to a lesser extent, Renoster Shrubland show a number of links with fynbos. Both may have small amounts of restioids (<3%), non-ericaceous ericoid-leaved shrubs (<20%, e.g. *Passerina* and *Phyllica*), and proteoids (<3%). *Protea nitida* may occasionally be found in Clanwilliam. Other links between Clanwilliam and Renoster Shrubland are aphyllous shrubs and elytopappoids (<10% in Clanwilliam). Lobed-leaved shrubs are relatively characteristic of Clanwilliam Shrubland. There are quite a number of characters which are found in Tall Succulent Shrubland and Clanwilliam Shrubland. These include nanophyllous shrubs, relatively tall grasses (over 0.5 m and usually climbing within shrubs), ferns and stem spinescence. Fleshy-leaved shrubs may have a high cover (5–30%) in Clanwilliam. This is also a feature of Succulent Shrubland. Grass cover is usually below 15%.

Floristics: *Pteronia fasciculata*, *Relhania* sp., *Anthospermum* sp., *A. tricoatum*, *Crassula rupestris*, *Eberlanzia* sp., *Rhus glauca*, *R. dissecta*, *Eriocephalus africanus*, *E. capitellatus*, *Euryops speciosissimus*, *Passerina obtusifolia*, *P. glomerata*, *Phyllica villosa* and *Agathosma ovata*.

Distribution: Mostly I, NW & SI (Fig. 10). Unlike the other series of the Karroid & Renoster group, Clanwilliam Succulent Shrubland is probably more or less restricted to the mountains, as it is a community of quartzite-derived soils.

Environment: The soils of Clanwilliam Karroid Shrubland can be deep colluvial soils (e.g. Clovelly Form) or shallow lithosols (e.g. Mispah Form), but they are always derived from T.M. or Witteberg quartzites. Clanwilliam Karroid Shrubland occurs on sites more mesic relative

to the Succulent Shrubland that occurs on quartzites, and on sites more xeric relative to fynbos.

Synonymy: Examples of Clanwilliam Karroid Shrubland include Milton's (1978) *Passerina–Euphorbia* and *Passerina glomerata* Communities from the Clanwilliam district, and include those facies of Bond's (1981) *Crassula rupestris–Digitaria natalensis* Community in which *Passerina obtusifolia* is found.

Renoster Shrubland

Stratification: 32, 34, 43.

Formations: Inland Renoster Shrubland. Low, open to mid-dense, leptophyllous shrubland (Fig. 12); Coast Renoster Shrubland. Low to mid-high, mid-dense to closed, leptophyllous shrubland; Grassy Renoster Shrubland. Low, mid-dense, leptophyllous shrubland with an open, grassy understorey.

Differentiating features: Renoster Shrubland includes a range of structural formations and is chiefly differentiated from the previous three series by the very high cover of leptophylls, the high cover of elytopappoids (10–90%) and the generally higher total cover. There are too few plots in the present study to make all but a preliminary subdivision of Renoster Shrubland. Inland Renoster Shrubland has a high cover of pubescent shrubs or a high cover of succulence or both, and it is the only type with a total cover of less than 60%. Coast Renoster Shrubland has a higher total cover (>75%) and is taller (>1 m). Grassy Renoster Shrubland is distinguished by having a high cover of perennial grasses (>30%). Microphyllous shrubs are found in Renoster Shrubland, a feature also found in Tall Succulent Shrubland. Some fynbos elements may be found in Renoster Shrubland (e.g. <20% non-ericaceous ericoids, <10% restioids).

Floristics: *Elytropappus rhinocerotis*, *Pteronia incana*, *Anthospermum aethiopicum*, *Dodonaea viscosa*, *Pentstemon colorata*, *Relbunium squarrosus*, *Helichrysum cymosum*, *Ruschia* spp. and *Themeda triandra*.

Distribution: NW, I & SI (Fig. 10).

Environment: Renoster Shrubland is usually found on finer-textured soils than fynbos. If on quartzites, then it occurs on more xeric sites than fynbos. It therefore occupies a position similar to Clanwilliam, being found on the ecotone between fynbos on the one hand, and Succulent Shrubland or Tall Succulent Shrubland on the other. It is environmentally distinguished from Clanwilliam by its association with fine-textured soils that are usually not quartzite-derived.

Synonymy: Boucher & Moll (1981) provide the most recent synthesis of Renosterveld. The present concept of Renoster Shrubland is probably narrower than theirs. Moffett & Deacon's (1977) data illustrate the differences between our various concepts of Renosterveld. Moffett & Deacon's Dense *Elytropappus* Shrubland, occurring on deep reddish-brown alluvial soils, is typical of my Renoster Shrubland, whereas their Dense *Passerina*-*Elytropappus* Shrubland, occurring on T.M. quartzites, approaches my Witteberg Mesotrophic Asteraceous Fynbos. Their *Passerina*-*Elytropappus* Shrubland is dominated by *Passerina obtusifolia* and *Elytropappus rhinocerotis* and also includes *Muraltia ericifolia*, *Agathosma roodebergensis* and *Restio fruticosus*. Boucher & Moll (1981) include, especially in their Coastal Renosterveld, what I would term fynbos (e.g. Witteberg Mesotrophic Asteraceous Fynbos, Weltevrede Dry Proteoid Fynbos, and Gydo Talus Asteraceous Fynbos). Acocks's (1953 & 1975) Renosterveld types (Mountain and Coastal) represent a narrower concept than the Renoster Shrubland presented here or by Boucher & Moll (1981). All communities dominated by *Elytropappus rhinocerotis* are

included in Inland Renoster Shrubland whereas the Mountain Renosterveld of Acocks (1953 & 1975) only includes those communities that are not derived communities. It is mostly impossible to determine whether a renoster community is derived or not. My Coast Renoster Shrubland approaches the Coastal Renosterveld concept (Acocks, 1953 & 1975; Boucher & Moll, 1981). However, much of the Renoster Shrubland that occurs in inland sites would be classed in my Coast Renoster Shrubland when it occurs in situations that are relatively mesic. The distinction is therefore a mesic/xeric distinction rather than a coastal/interior distinction. My concepts are supported by the work of Cowling (1984) as many of the character species of his South Coast Renosterveld Communities are found in my plots of renosterveld from inland valleys. Cowling (1984) describes various types of Grassy Renoster Shrubland (e.g. his *Elytropappus rhinocerotis*-*Eustachys paspaloides* Hankey Coast Renosterveld).

Grassland & Grassy Shrubland (Group S) (Table 11 and Key 4)

Baviaanskloof Grassy Shrubland (Series S1)

Stratification: 43, 32.

Formation: Sparse grassland with low to tall, sparse, leptophyllous and nanophyllous shrubs.

Differentiating features: The main distinguishing characters of this series are the low total cover (<50%) and the presence of climbers and stem succulents.

Floristics: *Euclea crispa*, *Pappea capensis*, *Rhus dissecta*, *Dodonaea viscosa*, *Euryops spathaceus*, *Sutera aspalathoides*, *Themeda triandra*, *Aristida junciformis*, *Ehrharta* sp., *Eragrostis curvula* and *Cymbopogon marginatus*.

FIG. 12.—Inland Renoster Shrubland on silcretes near the Baviaanskloof. This stand of Inland Renoster Shrubland, with *Elytropappus rhinocerotis*, *Pteronia incana* and *Ruschia* sp. dominating, has occasional thicket clumps as shown in the figure. This example of thicket would be classified as Kaffrarian Succulent Thicket and is dominated by *Rhus longispina*, *Euclea undulata* and *Olea europaea* subsp. *africana*. Northern Kouga, c. 900 m.



KEY 4.—Key to the series of Grassland & Grassy Shrubland

1. <75% total cover and/or <50% grass cover
 - 1.1 <50% total cover, <5% restioids Baviaanskloof Grassy Shrubland
 - 1.2 >50% total cover, or if lower then >10% restioids
 - 1.2.1 >15% non-ericaceous ericoids Bosrug Grassy Shrubland
 - 1.2.2 <15% non-ericaceous ericoids Seweweekspoort Grassy Shrubland
2. >75% total cover: usually absent: stem succulents, climbers, tall succulents, or >5% elytropappoids
 - 2.1 <50% shrub cover, <30% non-ericaceous ericoids
 - 2.1.1 Hummock grasses dominant Waterkloof Grassland
 - 2.1.2 Not as above
 - a. >20% restioids or >5% aphyllous grasses or >10% proteoids <1 m or >75% evergreen geophytes Suurberg Grassland
 - b. Not as above Hankey Grassland
 - 2.2 >50% shrub cover or >20% non-ericaceous ericoids Elandsberg Grassy Shrubland

Distribution. E (Fig. 13). However, occasional examples of Baviaanskloof Grassy Shrubland have been recorded elsewhere (e.g. SI).

Environment: The Baviaanskloof Series occurs under very low rainfall conditions (mostly below 500 mm p.a.) on rocky slopes. Soils range from Mispah to Hutton Forms.

Synonymy: Moffett & Deacon's (1977) Bush-Shrub-Grass-Herbland vegetation on limestone is best placed in the Baviaanskloof Series. No detailed descriptions of Baviaanskloof Series are available.

Bosrug Grassy Shrubland (Series S2)

Stratification: 34, 43.

Formation: Low to mid-high, open, ericoid shrubland with an open, grassy understorey.

Differentiating features: Total cover in Baviaanskloof, Bosrug and in Seweweekspoort Grassy Shrubland is low (usually less than 70%) and this feature sets these series apart from the other series in Grassland & Grassy Shrubland. Baviaanskloof, Bosrug and Seweweekspoort are further linked by a low grass cover (less than 60%) and a considerable proportion of the biomass is in the 1–1,5 m height class, whereas in the other series (Hankey, Elandsberg, Suurberg and Waterkloof) a considerable proportion of the biomass is in the 0,25–0,5 m height class. Bosrug is distinguished from the two other series in which total cover is low, by being dominated by

ericoid shrubs, a feature that may also be found in the high-cover Elandsberg Grassy Shrubland. Succulents often have a high cover (>10%) in Bosrug. Elytropappoids are often present, and restioids may be present but with very low cover (<5%).

Floristics: *Phyllica axillaris*, *Passerina pendula*, *Themeda triandra*, *Cliffortia apiculata*, *Pentastichis eriostoma*, *Danthonia arundinacea*, *Ruschia* sp. and *Tristachya leucothrix*.

Distribution: E (Fig. 13).

Environment: Bosrug, like Baviaanskloof, occurs under low-rainfall regimes (below 600 mm per annum). It appears that Baviaanskloof occurs under hotter and drier conditions than Bosrug (e.g. at lower altitudes in the Baviaanskloof Mountains). Bosrug is mostly associated with Mispah Form soils, but deeper Hutton Form soils were also recorded.

Seweweekspoort Grassy Shrubland (Series S3)

Stratification: 32 but also 43, 56.

Formation: Low, open to mid-dense, grassy, leptophyllous shrubland usually with mid-high, sparse, large-leaved shrubs (Fig. 14).

Differentiating features: A total cover of 50–70% combined with the absence or low cover of ericoid shrubs sets this series apart from the other series of Grassland & Grassy Shrubland. Elytropappoids are found in this

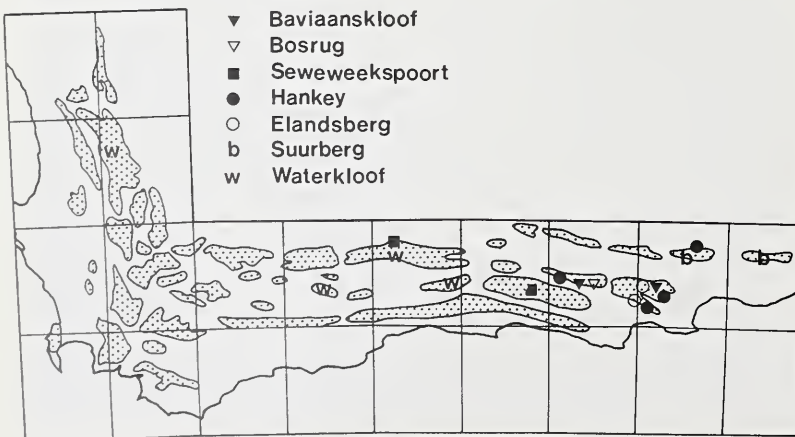


FIG. 13.—Distribution of Grassland & Grassy Shrubland.

FIG. 14.—Seweweekspoort Grassy Shrubland on T.M. quartzites. This example shows a grassy understorey (*Pentaschistis colorata* and *Themeda triandra*) and a mid-dense shrub cover (mostly *Anthospermum paniculatum*). The taller shrubs in the background include *Dodonaea viscosa*. *Aloe ferox*, as shown here, is often present in Seweweekspoort. Kouga, c. 1 100 m.



series and in Bosrug, and tall (>1 m) rosulate succulents are found in this series and in Baviaanskloof. Ericaceae, proteoids (including *Protea nitida*) and restioids may be present in amounts up to 20%. Fleshy-leaved shrubs are always present with 1–20% cover.

Floristics: *Montinia caryophyllacea*, *Pentaschistis tortuosa*, *Anthospermum paniculatum*, *Dodonaea viscosa*, *Relhania speciosa*, *Themeda triandra*, *Acmadenia sheilae*, *Aspalathus* sp., *Tristachya leucothrix*, *Restio gaudichaudianus*, *Hypodiscus striatus*, *Pentaschistis eriostoma*, *P. colorata* and *Cymbopogon marginatus*.

Distribution: SI (Fig. 13).

Environment: Seweweekspoort usually occurs at higher altitudes (800–1 300 m) than Bosrug or Baviaanskloof, and under slightly higher annual rainfall (500–700 mm). However, its characteristic environmental feature is its restriction to deep valleys (kloofs) in the Southern Interior Mountain Region (e.g. Seweweekspoort). Soils are mostly of the Mispah Form, but Clovelly and Hutton Forms were also recorded.

Hankey Grassland (Series S4)

Stratification: 21, 32.

Formation: Closed grassland with sparse or very sparse, low shrubs (Fig. 15).

Differentiating features: There are no characters that are restricted to this series. This series and those that follow have a high total cover, a high grass cover, a considerable amount of cover in the 0.25–0.5 m height class, and a high constancy of erect and rosette forbs. In physiognomy, Hankey is a grassland and as such is only similar to two other series, Suurberg Grassland and Waterkloof Grassland. The xeric nature of Hankey Grassland is indicated by a number of characters which link

it to the three low-cover series, e.g. stem spinescence, aphyllous shrubs and succulents (mainly rosulate succulents). Fynbos elements such as proteoids (including *Protea nitida*) restioids and ericoids (including Ericaceae) have low constancy and never have >20% cover. Two extremes of Hankey can be recognized, a sweetveld with grasses such as *Themeda triandra* and *Heteropogon contortus* and with no fynbos elements, and a sourveld with grasses such as *Tristachya leucothrix* and *Merxmuellera stricta*, and numerous fynbos elements.

Floristics: *Themeda triandra*, *Tristachya leucothrix*, *Heteropogon contortus*, *Diheteropogon filifolius*, *Elinurus muticus*, *Anthospermum paniculatum*, and occasionally *Thamnus multiflorus*, *Hypodiscus striatus*, *Phylica axillaris*. Emergents include *Protea nitida*, *Aspalathus* sp. cf. *A. chortophila* and *A. arenaria*.

Distribution: Mostly E (Fig. 13).

Environment: Hankey occurs under mean annual rainfall regimes of 600–700 mm, and on soils of 0.2–0.5 m depth. Rockiness is usually over 50%, and aspects are most often northerly. Rainfall is lower than that of most Grassy Fynbos that may occur on the same transect, or if Grassy Fynbos and Hankey Grassland occur adjacent to one another, then Hankey Grassland is found on the finer-textured soils (e.g. shalebands high in the Baviaanskloof Mountains). Most soils were classified as being of Glenrosa Form.

Synonymy: Both Hankey and Suurberg Grassland approach Acocks's (1953 & 1975) Dohne Sourveld, the exception being one of the two plots of Hankey Grassland from the Baviaanskloof Mountains which has a high cover of C₃ grasses *Pentaschistis eriostoma* and *Merxmuellera stricta* (R.P. Ellis, pers. comm.). The Baviaanskloof Mountains are the western limit for grassland communities. Of the 2 plots in the Baviaanskloof, the



FIG. 15.—Hankey Grassland. The dominant grasses include *Apochaete hispida* (the coarse grass), *Themeda triandra* and *Aristida junciformis* and the low shrubs that can be seen are mainly *Hermannia flammea*. *Protea nitida*, the tall shrub in the foreground, is an occasional emergent in Hankey. Hankey Forest Station, Elandsberg, c. 500 m.



FIG. 16.—Elandsberg Grassy Shrubland. This example of Elandsberg shows a closed grass layer (*Apochaete hispida*, *Aristida junciformis* and *Themeda triandra*) and a low open shrub layer (mostly *Metastasia muricata* and *Anthospermum aethiopicum*). Winterhoek Mountains (east), c. 600 m.

plot with C₃ grasses comes from quartzites whereas the plot with C₄ grasses comes from a shaleband. Martin & Noel (1960) provide descriptions of Hankey and Suurberg Grassland under their concept of Temperate Grassland Formation. The *Themeda* cover state of Cowling's (1984) *Themeda triandra*—*Cliffortia linearifolia* Humansdorp False Fynbos is best placed in Hankey Grassland.

Elandsberg Grassy Shrubland (Series S5)

Stratification. Variable — 21, 32, 62.

Formation: Low, closed, grassy shrubland (usually leptophyllous) (Fig. 16) or a mid-high to tall, open shrubland

with a closed, grass understorey (Fig. 17).

Differentiating features: This is the only high-cover series which is physiognomically a grassy shrubland, not a grassland. It has, unlike the three grassland series, over 50% cover of shrubs. The shrubs are nanophyllous proteoids (tall examples of *Leucadendron salignum*), ericoids, or deciduous shrubs (*Montinia caryophyllacea*). There are a number of characters which link Elandsberg with the previous four series: fleshy-leaved shrubs, broad leptophylls, deciduous shrubs, ferns, microphylls, and relatively tall growth forms (vegetation up to and including the 2–5 m height class). Elandsberg lacks >10% restioids.

Floristics: *Leucadendron salignum*, *Tristachya leucothrix*, *Aristida junciformis*, *Themeda triandra*, *Anthospermum aethiopicum*, *Metalasia muricata*, *Phyllica axillaris*, *Elionurus muticus* and *Erica pectinifolia*.

Distribution: E (Fig. 13).

Environment: Relative to Hankey, Elandsberg is found on more southerly aspects, and soil depth may often be great (e.g. 0,8–1,0 m Oakleaf Form soils). Rainfall varies from 600–800 mm *per annum*.

Synonymy: Cowling's (1984) *Themeda triandra*–*Cliffortia linearifolia* Humansdorp False Fynbos is an example of Elandsberg Grassy Shrubland. He recognizes two cover states, a *Themeda triandra* cover state and a derived *Cliffortia linearifolia* cover state. It is the latter cover state which approximates Elandsberg. Other examples of Elandsberg can be found in the descriptive accounts of fynbos from the afromontane regions in the eastern Cape and Drakensberg, e.g. Trollope & Booysen's (1971) Highland Macchia (Fynbos) of *Cliffortia linearifolia* and *C. paucistaminea*, and some of Martin & Noel's (1960) grass heath.

Suurberg Grassland (Series S6)

Stratification: 21, 32.

Formation: Closed grassland usually with other graminoids or near-graminoids (10–40% cover of sedges, restioids, and/or evergreen geophytes including bobartioids) (Fig. 18). Occasionally with sparse, low proteoids and ericoids.

Differentiating features: Characters which differentiate this series from other series of Grassland & Grassy Shrubland include pubescent forbs, a high cover of aphyllous sedges, microphyllous geophytes, >5% Ericaceae, and low (<1 m) nanophyllous proteoids. Meso-

macrophyllous evergreen geophytes and bobartioids link Suurberg Grassland and Elandsberg Grassy Shrubland. Restioids are relatively constant and often over 20% cover, and erect forbs have their greatest constancy in Suurberg Grassland.

Floristics: *Tristachya leucothrix*, *Restio triticeus*, *Themeda triandra*, *Diheteropogon filifolius*, *Bobartia orientalis*, *Leucadendron salignum* and *Tetraria exilis*.

Distribution: E (Fig. 13).

Environment: Suurberg occurs under a mean annual rainfall of about 700 mm. In contrast to Hankey, soils are usually with low rock cover (mostly below 50%). Soil depth varies from 0,3–0,6 m. If Hankey and Suurberg are found on the same transect, then Hankey mostly occurs on the dry north slopes and Suurberg on the mesic south slopes. Most Suurberg soils were classified as Glenrosa, but also recorded were Nomanci, Oakleaf and Swartland Forms.

Synonymy: See Hankey Grassland.

Waterkloof Grassland (Series S7)

Stratification: 32.

Formation: Closed grassland.

Differentiating features: In this grassland community, grasses are almost the only growth-form present. However, in some facies, restioids have up to 40% cover suggesting that this series could be more correctly termed Waterkloof Grassland & Grassy Fynbos. The grasses present are hummock grasses and are further distinctive in that they fall in the 0,5–1,0 m height class (being 0,5 m above the level of the ground between the hummocks).

FIG. 17.—Elandsberg Grassy Shrubland. This example of Elandsberg, when compared to that in Fig. 16, shows the variability encountered in Elandsberg, the only common features being the grass understorey and the fynbos overstorey shrubs. The shrubs in this figure include *Phyllica axillaris*, *Leucadendron salignum* and *Leucospermum cuneiforme*, whereas the understorey consists mainly of *Elionurus muticus*, *Lanaria lanata*, *Cymbopogon marginatus*, *Themeda triandra* and *Aristida junciformis*. Winterhoek Mountains (east), c. 150 m.





FIG. 18.—Suurberg Grassland. The dominant herbaceous plants in this example include *Apochaete hispida*, *Sporobolus* sp., *Tetraria exilis*, *Restio triticeus* and *Bobartia orientalis*. Some of the shrubs in the background are *Leucadendron salignum*. Suurberg, c. 750 m.

Floristics: *Merxmuellera stricta* (over 70% cover) and *Helichrysum niveum*.

Distribution: SI & NW (Fig. 13).

Environment: Waterkloof occurs as localized patches within landscapes dominated by fynbos. It usually occurs at high altitudes (over 1 300 m), on deep, rock-free soils adjacent to seasonally dry streams or adjacent to seepages. Relative to other phreatic types of fynbos, Waterkloof has a more easterly distribution, or if it is found in the west, then it is on shalebands. Soils are not organic, and are often non-red series of Oakleaf Form.

Synonymy: The restioid facies of Waterkloof Grassland structurally approaches Cowling's (1984) *Thamnochortus fruticosus*–*Tristachya leucothrix* Tsitsikamma Restioid Grassland which he places in Grassy Fynbos.

Cowling's community is also found in seasonally waterlogged areas but is, however, floristically unrelated to Waterkloof.

Discussion

Relationships to fynbos

Many of the series of the non-fynbos groups show close relationships with fynbos. This is not surprising as the study area is essentially a fynbos-dominated landscape with small pockets of non-fynbos communities.

Of the Forest & Thicket Group, Mitchell Thicket has a number of fynbos elements (e.g. leaf-spinescent shrubs, restioids). This series always occurs in very localized stands surrounded by fynbos. It is also the only series of Forest & Thicket that is restricted to the mountains of the study area.

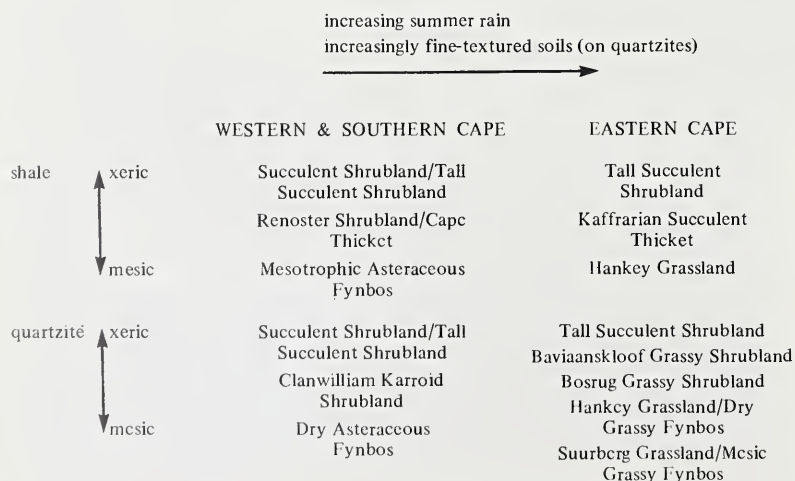


FIG. 19.—Environmental relationships among some non-fynbos communities, and environmental relationships between these communities and fynbos.

Of the Karroid & Renoster Shrublands, it is Clanwilliam Karroid Shrubland which shows a close relationship with fynbos. Once again, it is the only series of the group which appears to be restricted to the mountains of the study area. Like fynbos, it occurs on quartzite-derived soils but it occurs at an annual rainfall insufficient to support fynbos. It can form relatively extensive belts of vegetation on the ecotone between Succulent Shrubland and Fynbos. On the ecotone between Renoster Shrubland and Fynbos, different sorts of communities occur and I have placed these communities in Fynbos (e.g. Witteberg Mesotrophic Asteraceous Fynbos) because they usually have considerable amounts of restioids. This ecotone is a soil-related ecotone and occurs at higher rainfall regimes than the ecotone on which Clanwilliam Karroid Shrubland occurs.

In the Grassland & Grassy Shrubland group, most of the series show links with fynbos, the exception being Baviaanskloof Grassy Shrubland, the most xeric series of the group. Seweweekspoort Grassy Shrubland has many links with renoster Shrubland (e.g. *Dodonaea viscosa*, *Aloe ferox* and *Elytropappus rhinocerotis*), but it also contains fynbos elements (e.g. *Restio gaudi-*

chaudianus, *Hypodiscus striatus*, *Acmadenia sheilae* and *Protea nitida*).

It is in the case of Elandsberg Grassy Shrubland that my concept of fynbos can be questioned. Ericaceae play a more important role in the definition of fynbos than do other ericoid-leaved shrubs. In general, this is acceptable because Ericaceae are central to a definition of fynbos whereas other ericoid-leaved shrubs are often on the fynbos/non-fynbos transition (e.g. *Phyllica*, *Passerina*, *Cliffortia*). Therefore Elandsberg Grassy Shrubland with up to 40% cover of ericoid-leaved shrubs and occasionally up to 30% cover of *Leucadendron salignum* is placed in non-fynbos whereas Grahamstown Grassy Fynbos with 50–90% cover Ericaceae is placed in fynbos even though Elandsberg and Grahamstown share a number of characters (e.g. absence or low cover of restioids, dominance by a single or a few species of leptophyllous ericoid shrubs). The critical issue is to recognize the transitional nature of these communities, particularly Elandsberg and Grahamstown but also Bosrug, Seweweekspoort, Hankey and Suurberg. Fig. 19 illustrates some of the environmental relationships between fynbos and non-fynbos.

TABLE 12.—The fynbos communities of the mountains of the Fynbos Biome. The alphanumeric codes of the communities are also indicated. All types are named after localities in the Fynbos Biome

Group	Fynbos					
Series	Grassy Fynbos (Series G)	Asteraceous Fynbos (Series A)	Restioid Fynbos (Restioveld) (Series R)	Ericaceous Fynbos (Heath) (Series E)	Proteoid Fynbos (Proteaveld) (Series P)	Closed-Scrub Fynbos (Series C)
Subseries (upper case) and Types (lower case)	DRY GRASSY FYNBOS (Gd) Groendal (Gd1) MESIC GRASSY FYNBOS (Gm) Sundays (Gm1) Vaalvlei (Gm2) Engelseberg (Gm3) MESOTROPIC GRASSY FYNBOS (Ge) Mannetjiesberg (Ge1) Grahamstown (Ge2)	DRY ASTERACEOUS FYNBOS (Ad) Katbakkies (Ad1) Sebrafontein (Ad2) MESOTROPIC ASTERACEOUS FYNBOS (Ae) Witteberg (Ae1) Beakos (Ae2) Bantamskop (Ae3) OLIGOTROPIC ASTERACEOUS FYNBOS (Ao) Algeria (Ao1) Wuppertal (Ao2) Oukraal (Ao3) Fisantkraal (Ao4) TALUS ASTERACEOUS FYNBOS (At) Gydo (At1) Rooiberg (At2) Uitkyk (At3) Brandwag (At4)	DRY RESTIOID FYNBOS (Rd) Winterhoek (Rd1) Hex (Rd2) MESIC RESTIOID FYNBOS (Rm) Kouga (Rm1) Jonaskop (Rm2) Horingberg (Rm3) AZONAL RESTIOID FYNBOS (Ra) Wolfberg (Ra1) Trident (Ra2) Langberg (Ra3) Boesmansbos (Ra4) Fonteinjiesberg (Ra5) Sneeukop (Ra6) Crystal (Ra7)	MESIC ERICACEOUS FYNBOS (Em) Tafelberg (Em1) Nuweberg (Em2) Landdros (Em3) WET ERICACEOUS FYNBOS (Ew) Ruitersberg (Ew1) Keurbos (Ew2)	MESOTROPIC PROTEOID FYNBOS (Pe) Studtis (Pe1) Swarbos (Pe2) Enon (Pe3) DRY PROTEOID FYNBOS (Pd) Weltevrede (Pd1) Gymanshoek (Pd2) Hawequas (Pd3) Cango (Pd4) Benetive (Pd5) Thomas (Pd6) Ararat (Pd7) MESIC PROTEOID FYNBOS (Pm) Jonkershoek (Pm0) Dassieklip (Pm1) Toverwater (Pm2) Sanddrift (Pm3) Swartberg (Pm4) Bloukrans (Pm5) Sipres (Pm6) Robinson (Pm7) Kammanassie (Pm8) Loerie (Pm9) WET PROTEOID FYNBOS (Pw) Outeniqua (Pw1) Otterford (Pw2) Mangold (Pw3) Kouma (Pw4)	Witriver (C1) Dwarsrivier (C2) Meulrivier (C3)

Chapter 7

Fynbos series

The primary division of Fynbos is into Eastern Fynbos and Mountain Fynbos. Taylor (1978) and Kruger (1979a) discuss the increased grassiness of fynbos towards the east, but do not recognize a separate Eastern Fynbos. Cowling (1984) has also made the Eastern/Mountain distinction in his work. Within the subgroup of Mountain Fynbos five fynbos series are recognized, whereas in the subgroup Eastern Fynbos a single series is recognized viz Grassy Fynbos (Fig. 7).

The results and discussion presented below are mostly extracted from Campbell (1985b). An overview of the classification of fynbos is presented in Table 12.

Grassy Fynbos (Series G)

Differentiating features: Grassy Fynbos is differentiated from the series of Mountain Fynbos by having a high grass cover. This high grass cover links it to the non-fynbos Grassland & Grassy Shrubland group and to Afromontane Fynbos. Other features which these three communities probably share, and which are lacking in Mountain Fynbos, are a relatively high cover of non-proteoid nanophylls and forbs (especially rosette forbs), and the presence of rosulate succulents, low nanophyllous proteoids and pubescent forbs.

Distribution. E (Fig. 5).

Environment: The important environmental features of Grassy Fynbos relate to the eastern distribution of this series. Soils are finer textured in the east and summer drought is less pronounced. Soil-nutrient levels are slightly higher in Grassy Fynbos relative to most Mountain Fynbos.

Asteraceous Fynbos (Series A)

Differentiating features: Relative to other fynbos series, Asteraceous Fynbos has a lower total cover (30–70%), with only one of its sub-series, Talus Asteraceous Fynbos having a consistently higher cover. Asteraceous Fynbos can be further distinguished from other series of Mountain Fynbos by often having a high grass cover and/or elytropappoid cover (although grass cover is never as high as in Grassy Fynbos), and by having a high non-ericaceous shrub cover relative to restioids and sedges. The shrub cover often consists of non-ericaceous ericoid

shrubs (Thymelaeaceae, Asteraceae, Rhamnaceae). Features in common with the non-fynbos groups (Grassland & Grassy Shrubland and, especially, Karroid & Renoster Shrubland) are low total cover, occasional high cover of non-ericaceous ericoid shrubs, succulents and fleshy-leaved shrubs, the presence of broad leptophylls, deciduous shrubs and microphyllous geophytes, and the high constancy of stem spinescence. Sedge cover is particularly low in Asteraceous Fynbos. All Mountain Fynbos with *Protea nitida* falls into Asteraceous Fynbos except in the cases where seed-regenerating proteoids exceed 10% cover.

Distribution: Throughout the Biome excluding the Eastern Mountain Region. Most common in the Interior Region and least common in the Southern Coastal and South-Western Regions.

Environment: Asteraceous Fynbos tends to occupy the driest fynbos sites. Relative to Restioid Fynbos, where soils are similarly shallow and rocky, it is found at lower altitudes and lower annual rainfall, or on steeper, more xeric, slopes. In the four subseries, mean annual rainfall ranges from 450 mm to 950 mm and altitude ranges from 800 m to 1 350 m. Apart from one subseries (Talus Asteraceous Fynbos), soil depths average less than 0.4 m.

Restioid Fynbos (Series R)

Differentiating features: Restioid Fynbos is mainly distinguished by having a high graminoid cover (>60%) of restioids and in some cases of sedges, and by having a low cover of shrubs (usually less than 30%). The important feature is the low ratio of shrubs to graminoids. Another feature of some types of Restioid Fynbos is the alpine stature. Restioid Fynbos shares a number of features with Asteraceous Fynbos, including ericoid Asteraceae, leaf spinescence, aphyllous grasses and pubescent forbs. These features are not as characteristic of Ericaceous or Closed-Scrub Fynbos but may be found in non-fynbos (e.g. pubescent forbs and aphyllous shrubs are found in Grassland & Grassy Shrubland). Of all fynbos, Restioid Fynbos has the lowest constancy and cover of tall (>1.5 m) shrubs. Ferns are lacking to a greater extent in Restioid Fynbos than in the other series (with short deciduous ferns in Asteraceous and Grassy Fynbos and with tall evergreen ferns in Closed-Scrub and Ericaceous Fynbos).

KEY 5.—Key to the Fynbos Series

1. >10% mid-high to tall (>1 m) seed-regenerating proteoids, with these proteoids being the dominant element in the canopy layer **Proteoid Fynbos** (Key 10)
2. >30% grass
 - unless 20–40% Ericaceae, usually 20–60% restioids, <50% grass
 - unless >40% Ericaceae (usually 4–8 species), usually 20–60% restioids, >5% sedges, pubescent shrubs uncommon, and often present: Penaeaceae, Bruniaceae and proteoids (Ericaceous Fynbos)
 - unless <40% grass, >30% restioids
 - or <5% restioids, grass cover > restioid cover, >80% Ericaceae (usually 1 species) (Grahamstown Grassy Fynbos)
 - or >10% grass, <30% restioids, >40% non-ericaceous ericoids, >70% total cover (Mannetjesberg Grassy Fynbos) **Grassy Fynbos** (Key 6)
3. *Protea nitida* present **Asteraceous Fynbos** (in part, Key 7)
4. *P. laurifolia*, *P. repens*, *P. neriifolia*, *P. lorifolia* not present and one of the following 4 statements:
 - 4.1 >40% in total of one or more of the following: Ericaceae, Bruniaceae, Penaeaceae, ericoid Grubbiaceae, ericoid Rosaceae
 - unless >40% Ericaceae, <5% of the other abovementioned elements, >50% restioids which are taller than the Ericaceae (e.g. Ericaceae 0,25 m, restioids 1,0 m) (Restioid Fynbos)
 - 4.2 >40% relative cover Ericaceae, vegetation mostly below 0,25 m (Tafelberg Ericaceous Fynbos)
 - 4.3 >30% Ericaceae, very wide sedges present (Nuweberg Ericaceous Fynbos)
 - 4.4 >25% Ericaceae, >15% sedges, >60% restioids, Penaeaceae present, other ericoids >20% **Ericaceous Fynbos** (Key 9)
5. >20% non-proteoid woody plants, 1–60% plumose restioids, tall (>1 m) grasses often present
 - unless >90% graminoid cover (Azonal Restioid Fynbos)
 - or >20% shrubs (usually >40%), >70% total cover, and one or more of the following: sprawling restioids, hummock grasses (without >40% plumose restioids), plumose restioids, >5% orthophyllous shrubs; and without: >1% elytropappoids or >1% succulents **Closed-Scrub Fynbos** (Key 11)
6. >50% restioids
 - unless >20% elytropappoids (Witteberg Mesotrophic Asteraceous Fynbos)
 - unless >60% non-proteoid shrubs
 - or <5% non-proteoid shrubs
 - or <20% non-proteoid shrubs
 - unless <40% total cover, <20% restioids (mostly Dry Asteraceous Fynbos)
 - unless >5% elytropappoids, <50% restioids, <5% sedges, >30% grass (Mesotrophic Asteraceous Fynbos)
 - unless <60% total cover, <30% restioids, <5% sedges, >10% grass
 - or >20% sedges
 - or 20–40% restioids, with similar restioid cover and non-proteoid shrub cover, <5% elytropappoids, grass usually <10%, often >5% sedges, often <10% non-ericaceous ericoids
 - or 30–50% restioids, 20–35% non-proteoid shrub cover, <10% elytropappoids, usually <10% grass, and often >5% sedges **Restioid Fynbos** (Key 8)
7. (Penaeaceae probably never >10%) **Asteraceous Fynbos** (Key 7)

Distribution: Found everywhere in the mountains apart from the Eastern Mountain Region. Restioid Fynbos is rare in the Southern Coastal Region.

Environment: Restioid Fynbos occurs where conditions are limiting for shrub growth. In Azonal Restioid Fynbos, this limitation is owing to waterlogging or to excessive drainage or to a combination of these conditions. Restioid Fynbos occupies more mesic sites than Asteraceous Fynbos (e.g. annual rainfall averages more than 1300 mm in the subseries), with the zonal Restioid Fynbos probably occurring under conditions where there is sufficient moisture to support a well-developed graminoid layer, but where there is insufficient deep percolation to allow a well-developed shrub layer (in contrast to Ericaceous Fynbos) (Bond, 1981; Campbell, 1985b). However, another important factor limiting shrubs in zonal Restioid Fynbos is the extremely shallow and rocky soils (soil depth averages 0,2–0,3 m in the subseries). Restioid Fynbos is a particular feature of north aspects, where soils are more droughty and shallower, with Ericaceous Fynbos being more associated with the deeper, more mesic soils of south aspects.

Ericaceous Fynbos (Series E)

Differentiating features: Asteraceous and Ericaceous Fynbos have a high cover of leptophyllous shrubs, but the latter Series, unlike the former, also has a high cover of restioids, and the shrubs are ericaceous ericoids or, in

one type, Bruniaceae and ericoids of the Grubbiaceae. Other characteristic features of most Ericaceous Fynbos are the high constancy of Penaeaceae and Bruniaceae, and the high cover of sedges (only Talus Asteraceous Fynbos has as high a sedge cover). Shrub cover and total cover are generally higher in Ericaceous Fynbos than in Asteraceous Fynbos. Very wide-leaved sedges are characteristic of one of the types of Ericaceous Fynbos. Proteoids, such as *Leucadendron loeriense*, *L. uliginosum*, *L. eucalyptifolium*, *L. gandogerii* and *Protea punctata* may be emergents in Ericaceous Fynbos, but the more xeric proteoids are never emergents in Ericaceous Fynbos (e.g. *P. laurifolia*, *P. lorifolia*, *P. repens*, *P. neriifolia*).

Some types of Asteraceous Fynbos and even some types of Restioid Fynbos have up to 40% cover of Ericaceae. However, features such as >10% Penaeaceae are never found in Asteraceous or Restioid Fynbos. Both these latter types have a higher constancy of pubescent shrubs, and may have emergent proteoid species that are never associated with Ericaceous Fynbos (e.g. *P. laurifolia*, *P. repens*, *P. lorifolia*, *P. eximia*). The ericaceous types of Asteraceous Fynbos have a much lower sedge and geophyte cover than Ericaceous Fynbos (particularly, lower in leafy sedges; evergreen geophytes usually 0–1%). These communities also have a higher constancy of mat proteoids and aphyllous grasses than Ericaceous Fynbos.

Distribution: Mostly SW & SC.

Environment: Ericaceous Fynbos is distinguished from most other fynbos series by having soils with a higher carbon content, a lower pH, and often a higher fine-particle fraction. The soils also tend to be deeper and less rocky than those of Asteraceous and Restioid Fynbos. Rainfall averages over 1 500 mm in Ericaceous Fynbos, and this series is most often associated with southerly aspects. See also Asteraceous and Restioid Fynbos.

Proteoid Fynbos (Series P)

Differentiating features: Proteoid Fynbos is primarily differentiated from other fynbos series by having >10% cover of mid-high to tall seed-regenerating proteoids. The woodland type of fynbos in which *Protea nitida* is the dominant tall shrub (or small tree), is excluded from the Proteoid Fynbos concept mainly because *P. nitida* is not seed-regenerating but also because *P. nitida* hardly ever exceeds 10% cover. Also excluded from Proteoid Fynbos are the stem-regenerating proteoids such as *Leucadendron salignum*. These species hardly ever exceed 1 m in height and many of them are nanophyllous whereas most of the proteoids of Proteoid Fynbos are microphyllous or mesophyllous. Vegetation dominated by *Leucadendron gandogerii* is represented in too few plots for its position in the classification to be finalized. *L. gandogerii* is usually a low proteoid (<1,5 m), and has for the present been excluded from the concept of Proteoid Fynbos (plots with up to 30% cover of *L. gandogerii* have been placed in Ericaceous Fynbos).

Proteoid Fynbos is often similar to Closed-Scrub Fynbos in stature and closure, but isobilateral shrubs are not characteristic of Closed-Scrub Fynbos. These two series both have a high cover of ferns. Evergreen geophytes have their highest average cover in Proteoid Fynbos, Ericaceous Fynbos and Grassy Fynbos. Leafy sedges have their highest cover in Proteoid, Ericaceous and Restioid Fynbos, and wide-leafy sedges are most characteristic of Proteoid Fynbos.

Distribution: Throughout the Biome excluding the Interior Mountain Region, and relatively rare in the North-Western Region and, to a lesser extent, in the Eastern Region. Most extensive in the Southern Coastal Region.

Environment: Relative to other series of Mountain Fynbos, Proteoid Fynbos generally occurs at lower altitudes and on deeper soils. The important environmental condition apart from the climatic conditions associated with the chiefly southern coastal distribution (mild moist conditions), is soil depth. Soils average 0,5 to 0,9 m deep in the subseries, and rockiness is not pronounced. The association of Proteoid Fynbos with low altitudes and, to a lesser extent, with southern slopes probably reflects the association of deep soils with lower altitudes and southern slopes. Altitude averages 750 m to 950 m in the subseries, and the mean annual rainfall ranges from 850 mm to 1 100 mm.

Closed-Scrub Fynbos (Series C)

Differentiating features: Closed-Scrub Fynbos shares many features with the non-fynbos Forest & Thicket

Group e.g. a high cover (often >40%) of tall microphyllous non-proteoid woody plants, a high cover of orthophylls, the presence of mesophylls, and a high cover of tall nanophyllous non-proteoid woody plants. However, it is distinguished from Forest & Thicket by its usually high cover of restioids (>10%), in particular of plumose restioids. Ericaceae are normally present albeit with low cover (e.g. 1–5%). Tall grasses are relatively characteristic.

Distribution: Found throughout the Biome except in the Eastern and Interior Regions.

Environment: Closed-Scrub Fynbos is associated with rivers and streams. However, not all streams and rivers have Closed-Scrub Fynbos. At lower altitudes, especially in the south and south-west, Forest and Wet Proteoid Fynbos may be found, whereas at higher altitudes some streams support Azonal Restioid Fynbos and Wet Ericaceous Fynbos. The riparian communities of these latter two subseries are associated with more waterlogged conditions than occur under Closed-Scrub Fynbos (see Table 26 for a summary of all communities of phreatic sites).

Discussion

Relationships with other fynbos classifications

Taylor's (1978) main subdivisions of fynbos were (1) Mountain Fynbos comprising the proteoid zone and the ericoid-restioid zone, and (2) Arid Fynbos and (3) Hygrophilous Fynbos. Arid Fynbos is equivalent to one of my communities, Dry Asteraceous Fynbos, but I see this community as only one of four subseries of Asteraceous Fynbos.

A further similarity between Taylor's subdivision and mine, concerns vegetation dominated by proteoids. However, Taylor's proteoid zone was primarily an altitudinal zone, and although much of the zone contains Proteoid Fynbos it also includes vegetation, often on shallow soils, which I would place in Restioid or Asteraceous Fynbos.

It is only with much difficulty that Taylor's ericoid-restioid zone can be matched to my system. It includes Grassy, Restioid, Asteraceous and Ericaceous Fynbos but of these series it excludes Dry Asteraceous Fynbos, and much of Wet Ericaceous Fynbos and Azonal Restioid Fynbos. These latter two subseries were placed in Taylor's Hygrophilous Fynbos. Closed-Scrub Fynbos is a subset of Taylor's Hygrophilous Fynbos. Hygrophilous Fynbos is structurally less homogeneous than Closed-Scrub Fynbos. It includes the tall ericaceous/bruniaceous communities of seepage areas (now placed in Wet Ericaceous Fynbos) and the restioid communities of marshes (now placed in Azonal Restioid Fynbos). Kruger's (1979a) class of fynbos occurring on phreatic sites, Adamson's (1938) Wet Sclerophyll Bush and Phillips's (1931) Hygrophilous Macchia, are also structurally heterogeneous, and are more akin to Taylor's Hygrophilous Fynbos than to my Closed-Scrub Fynbos.

Cowling (1984) distinguishes two major fynbos

categories in the mountains of the east, viz Mountain Fynbos and Grassy Fynbos. His concept of Grassy Fynbos differs slightly from that presented here. His definition is based largely on floristics, not structure. He includes grassy proteoid communities in Grassy Fynbos, whereas in my system these communities would be included in Proteoid Fynbos if the proteoids were seed-regenerating and had over 10% cover. His definition also lays stress on C₄ grasses, whereas mine does not distinguish between C₃ and C₄ grasses. Therefore, I place the western-most C₃ grassy communities in Grassy Fynbos, whereas he would probably place them in Mountain Fynbos. One further difference in concept concerns amount of grassiness. I have strict definitions regarding the cover of grass that must be present in Grassy Fynbos, whereas in Cowling's Grassy Fynbos a low grass cover is permitted provided that the floristics link the vegetation with Grassy Fynbos.

There is much similarity between my classification and the structural and floristic systems of Bond (1981). Bond's major categories, Heathlands, Proteoid Shrublands, Restioid Shrublands and Dry Shrublands correspond roughly with my Ericaceous Fynbos, Proteoid Fynbos, Restioid Fynbos and Asteraceous Fynbos respectively. The differences that exist relate mostly to the treatment of proteoids. His non-proteoid types occasionally have up to 75% cover of proteoids.

In the recently proposed schema of major vegetation categories in the Fynbos Biome (Moll *et al.*, 1984), six major fynbos categories are recognized, and two of these, viz Grassy Fynbos and Mountain Fynbos, are found on the mountains. The other four categories are characteristic of the non-mountain areas (Elim Fynbos,

Lowland Fynbos, Dune Fynbos and Limestone Fynbos).

Grassy Fynbos, False Macchia and Derived Fynbos

Acoccks (1953 & 1975) divided the fynbos of the mountains into two types, viz Macchia and False Macchia. Acoccks saw False Macchia as being derived from sour grassveld and other Afromontane communities. Cowling (1984) provides much evidence that the False Macchia concept is untenable. There are many regional and local endemics of fynbos affinity in the area mapped as False Macchia (Weimark, 1941; Cowling, 1984). To account for the presence of endemics, Acoccks (1979) proposed a 'rotating climax' as follows: scrub-forest (thicket) → grassland → fynbos → scrub-forest, with the conversion of scrub-forest to grassland being accomplished by fire. He suggested that dependent on fire frequency, any of the above vegetation types would be able to exist in the landscape. Acoccks (1953 & 1975) mentions that *Othonna*, *Euryops* and *Ursinia* spp. dominate in parts of the area mapped as False Macchia. This definitely does not apply to the mountain regions, though it may perhaps be true in the lowlands. The only area mapped as False Macchia that could possibly be derived fynbos exists in the area where Grassy Fynbos is found (i.e. in the extreme east of Acoccks's False Macchia). In this area one finds grassland adjacent to Grassy Fynbos, and one occasionally finds thicket. However, the patterns of distribution of grassland, Grassy Fynbos and thicket are consistently related to non-fire factors (aspect, altitude, rainfall and soil depth), and there is no need to invoke fire as the causal factor. The increased grassiness of the eastern communities has been related to factors such as higher growing-season temperatures and finer-textured soils (Cowling, 1984; Campbell, 1985b).

Chapter 8

Grassy Fynbos (Series G)

The classification of the Grassy Fynbos Series is set out in Table 13 and Key 6. The discussion of Grassy Fynbos in this chapter follows the classification scheme as outlined.

Dry Grassy Fynbos (Subseries Gd)

Groendal Dry Grassy Fynbos (Type Gd1)

Stratification: 32 to 42 (see Fig. 4, p.8).

Formation: Low, mid-dense, grassy shrubland usually with sparse restioids and occasionally with mid-high, sparse shrubs.

Differentiating features: Unlike the other types of Grassy Fynbos, this type has a number of xeric characters and I have indicated its distinctness by placing it in its own subseries, Dry Grassy Fynbos. Differentiating characters include succulents, aphyllous yellow-stemmed shrubs, ferns, rosulate succulents, tall nanophyllous shrubs (albeit with very low cover), stem spinescence, and up to 10% of elytropappoids. Groendal usually has 60–85% total cover whereas most other types of Grassy Fynbos have over 90%. Proteoids and Ericaceae, if present, have low cover (<10%). Fleshy-leaved shrubs have 1–30% cover, deciduous shrubs with up to 5% cover are usually present, and sedges have a low cover (<5%). Two facies can be recognized, one in which *C₃* grasses dominate (some of the plots in the Baviaanskloof) and the other in which *C₄* grasses dominate.

Floristics: *Themeda triandra*, *Restio fruticosus*, *Tristachya leucothrix*, *Cannomois dregei*, *Pentstemon erio-stoma*, *Hypodiscus striatus*, *Leucadendron salignum*, *Cliffortia apiculata*, *Diheteropogon filifolius*, and occasionally, *Phylla axillaris*, *Hermannia salviifolia*, *Agathosma ovata*, *Rhus lucida*, *Merxmüllera* spp., *Euryops* spp. Emergents sometimes include *Thesium strictum*, *Osteospermum imbricatum*, *Passerina pendula*, *Aloe ferox*, *Montinia caryophyllacea* and *Protea lorifolia*.

Distribution: E & SI (Fig. 20).

Environment: Of the types of Grassy Fynbos, Groendal occupies the most xeric sites (e.g. northerly aspects with 700 mm mean annual rainfall or southerly aspects with 500 mm mean annual rainfall). The soil is usually shal-

low (0,1–0,3 m deep) and rock cover is always above 50%. Groendal mostly occurs on quartzites but may also occur on silcretes or shales, and the soils are of the Mispah Form.

Synonymy: Most of my plots fall within Cowling's (1984) Grassy Fynbos, exclusive of plots from the Baviaanskloof Mountains which are dominated by *C₃* grasses rather than *C₄* grasses. Of Cowling's communities, the *Themeda triandra*–*Passerina pendula* Hankey Dry Grassy Fynbos best approximates my Groendal Grassy Fynbos. However, his community contains a high cover of elytropappoids which is not a feature of Groendal. His community is an extremely grassy equivalent of Witteberg Mesotrophic Asteraceous Fynbos. Martin & Noel's (1960) grass heath (dry facies) of their *Erica demissa*–mixed heath alliance is similar to Groendal.

Mesic Grassy Fynbos (Subseries Gm)

Differentiating features: Mesic and Mesotrophic Grassy Fynbos differ from Dry Grassy Fynbos in lacking the differential characters mentioned under Groendal Gd, and by sharing a high total cover (>90%), >10% Ericaceae, >60% non-proteoid woody plants, and >40% leptophylls. Proteoids are a particular feature of Mesic Grassy Fynbos (mainly low nanophyllous proteoids), and it is only in this subseries that sedges may be above 20%.

Environment: As the name implies, Mesic Grassy Fynbos occurs on more mesic sites than Dry Grassy Fynbos. Annual rainfall usually averages from 700 mm to 900 mm.

Sundays Mesic Grassy Fynbos (Type Gm1)

Stratification: 32, 34.

Formation: Low, closed, grassy, leptophyllous shrubland usually with low to mid-high, sparse, nanophyllous proteoids (Fig. 21).

Differentiating features: This type lacks good differentiating characters. One weak differential character that the Sundays Type possesses is the presence of proteoids over 1 m tall. Ericaceae are usually present but with less than 40% cover, restioids usually vary from 10 to 50% cover and grass varies from 30 to 90% cover.

KEY 6.—Key to the types of Grassy Fynbos

1. >50% Ericaceae, <20% sedges Grahamstown Mesotrophic Grassy Fynbos
2. >20% non-ericaceous ericoids, <20% proteoids Mannetjiesberg Mesotrophic Grassy Fynbos
3. >5% proteoids
unless: <90% total cover or >10% elytopappoids or >1% succulents
 - 3.1 >10% aphyllous sedges or >5% Bruniaceae or >10% mesophyllous proteoids Vaalvlei Mesic Grassy Fynbos
 - 3.2 Not as above Sundays Mesic Grassy Fynbos
4. Not as above
 - 4.1 >30% sedges, >90% total cover, >80% grass cover Engelseberg Mesic Grassy Fynbos
 - 4.2 Not as above Groendal Dry Grassy Fynbos

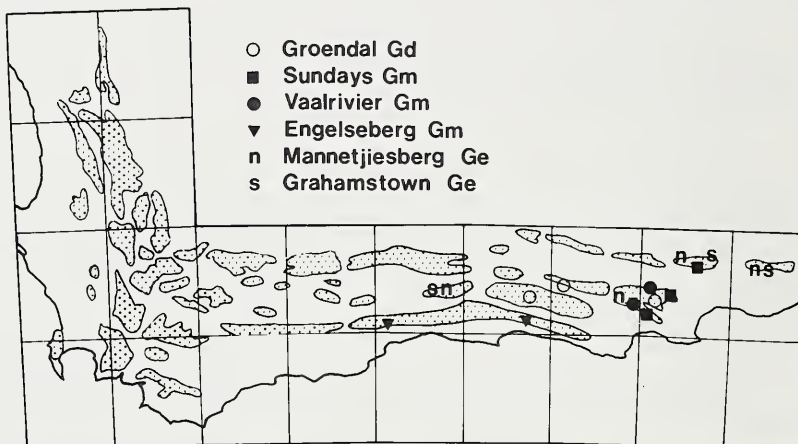


FIG. 20.—Distribution of Grassy Fynbos.



FIG. 21.—Sundays Mesic Grassy Fynbos on a ridge-top in the Suurberg Mountains, c. 800 m. Conspicuous in this example is *Leucadendron salignum* (light bush) and *Restio triticeus* (much of the dark matrix).

Floristics: *Restio triticeus*, *Leucadendron salignum*, *Phylica axillaris*, *Themeda triandra*, *Diheteropogon filifolius*, *Thamnus multiflorus*, *Lanaria lanata*, *Helichrysum anomalum* and *Aristida junciformis*. Highly constant dominant species are *R. triticeus* and *L. salignum*, and the Groendal and Sundays Types can be distinguished by the dominant restioids (*R. triticeus* in Sundays and *R. fruticosus*, *Cannomois dregei* or *Hypodiscus striatus* in Groendal).

Distribution: E (Fig. 20).

Environment: Mean annual rainfall usually ranges from 700 mm to 800 mm, and soil depths are greater (0.3–0.6 m) and rock cover is lower (mostly below 40%) than in Groendal Gd. If Groendal and Sundays Types occur on the same transect [e.g. in the Winterhoek (east)], then Groendal occupies the drier, more northerly aspects. The soils of Sundays are mostly of the Glenrosa Form, but Oakleaf and Nomanci Forms are also found.

Synonymy: Martin & Noel's (1960) grass heath (moist facies) of their *Erica demissa*–mixed heath alliance

FIG. 22.—Vaalvlei Mesic Grassy Fynbos. This stand has an understorey mainly of *Restio triticeus*, *Lanaria lanata*, *Themeda triandra* and *Elyonurus muticus*. The shrubs in the photograph include *Protea tenax*, *Phylica axillaris* and *Leucadendron salignum*. Winterhoek Mountains (east), c. 500 m.



approximates Sundays, as does Cowling's (1984) *Erica pectinifolia*–*Trachypogon spicatus* Humansdorp Grassy Fynbos.

Vaalvlei Mesic Grassy Fynbos (Type Gm2)

Stratification: 32.

Formation: Low, closed, graminoid, leptophyllous shrubland usually with sparse, low proteoids. Grasses are the most important graminoids, but also with high cover are restioids, sedges and/or the near-graminoids, evergreen meso-macrophyllous geophytes (Fig. 22).

Differentiating features: Vaalvlei is differentiated by a number of features including >10% fine aphyllous sedges, >5% mesophyllous proteoids, >20% fleshy-leaved shrubs, >10% Bruniaceae, >10% leaf spinescence, and cupressoids. Some of the above characters occur in other types of Grassy Fynbos, particularly Engelseberg and Sundays, but they never occur with as high a cover. Lobed-leaved non-proteoid shrubs and the occasional high cover of geophytes link Vaalvlei and Sundays, and these types are linked to Groendal Gd by bobartioid geophytes, fleshy-leaved shrubs and aphyllous shrubs.

Floristics: *Bobartia* sp., *Ehrharta dura*, *Euryops munitum*, *Lanaria lanata*, *Phylica axillaris*, *Protea tenax*, *Brunia nodiflora*, *Restio triticeus*, *Elyonurus muticus* and *Leucadendron salignum*.

Distribution: E (Fig. 20).

Environment: Vaalvlei occurs on more mesic sites than Sundays, either on more southerly slopes or at higher altitudes. Mean annual rainfall ranges from 700 mm to 900 mm and soils are of the Glenrosa and Mispah Forms. There is some evidence to indicate that Vaalvlei is a type derived from a more proteoid community.

Engelseberg Mesic Grassy Fynbos (Type Gm3)

Stratification: 23, 32.

Formation: Closed grassland or low, closed, grassy, ericaceous shrubland.

Differentiating features: Characteristic is the very high cover of grass (>80%), the high relative cover of graminoids, and the high cover of narrow-leafy sedges (>20%). In common with Vaalvlei Gm, Engelseberg has a high cover of sedges, and in particular of aphyllous sedges. Fine aphyllous sedges and narrow-leafy sedges are features that are shared with most of the previously described types of Grassy Fynbos. Ericaceae were high in one of the plots of Engelseberg. Engelseberg should more correctly be termed Engelseberg Grassland & Grassy Fynbos.

Floristics: *Ehrharta dura* (>70% cover), *Merxmuellera rufa*, *Tetraria* spp. (e.g. *T. flexuosa* and *T. fourcadei*), *Restio compressus* and *Erica* sp.

Distribution: SC (Fig. 20).

Environment: Engelseberg occurs at high altitudes (1000 m) in localized patches that are surrounded by fynbos. It has a similar environment to Waterkloof Grassland (S7), e.g. deep rock-free soils in seepage areas, but does appear to occur under more mesic conditions, and is not a feature of the interior mountains. Soils are of the Champagne form. Annual rainfall averages about 900 mm, but summer mists provide much further moisture.

Synonymy: The Engelseberg Type approaches Cowling's (1984) *Thamnochortus fruticosus*–*Tristachya leucothrix* Tsitsikamma Restioid Grassland in structure and environment, but not in floristics.

Mesotrophic Grassy Fynbos (Subseries Ge)

Differentiating features: The major distinguishing feature of Mesotrophic Grassy Fynbos is the high cover of Ericaceae (>50%) or of other ericoid shrubs (*Passerina*, *Cliffortia*) (10–80%). Mesotrophic Grassy Fynbos has a higher cover of non-proteoid woody plants, especially leptophylls, than Mesic Grassy Fynbos, and it also tends to be taller, usually with a considerable amount of cover above 1 m height.

Environment: Relative to Mesic Grassy Fynbos it appears that Mesotrophic Grassy Fynbos occurs under higher rainfall regimes (e.g. means of 900–1 000 mm p.a. are not uncommon). If Mesotrophic Grassy Fynbos and Mesic Grassy Fynbos are found adjacent to each other, then it is the former which occupies the more southerly aspects, or the deeper finer-textured soils.

Mannetjesberg Mesotrophic Grassy Fynbos (Type Ge1)

Stratification: 32 to 56.

Formation: Low to mid-high, closed, ericoid (non-ericaceous) shrubland with a mid-dense to closed, grass and restioid understorey.

Differentiating features: A high cover (>20%) of non-ericaceous ericoids separates Mannetjesberg from other types. Stoeboids and plumose restioids, although not constant, are also diagnostic. Sundays Gm may have up to 30% cover of non-ericaceous ericoids but, if so, it also has up to 30% cover of proteoids. Mannetjesberg never has more than 10% proteoids. Physiognomically, Mannetjesberg is similar to Grahamstown Ge but, unlike Grahamstown, it does share some characters with the previous types (e.g. the presence of non-ericaceous ericoid shrubs, evergreen meso-macrophyllous geophytes, and coarse aphyllous sedges). Grass cover varies from 10 to 80%.



Floristics: Variable except for *Passerina* spp. (*P. vulgaris* and/or *P. obtusifolia*). Other dominants include *Coleonema* sp., *Agathosma ovata*, *Cullumia decurrens*, *Helichrysum anomalum*, *Thamnus multiflorus*, *Stoebe incana*, *S. plumosa*, *Cliffortia striatus*, *Ehrharta ramosa*, *Elionurus muticus*, *Hypodiscus albo-aristatus*, *Restio triticeus*, *R. sejunctus*, *Elegia juncea* and *E. racemosa*.

Distribution. E & SI (Fig. 20).

Environment: Mannetjesberg usually occurs above 700 m elevation under mean annual rainfall regimes of 700 mm to 1 000 mm. When it occurs in the Southern Interior Mountain Region then it is usually associated with fine-textured soils (e.g. as on the shaleband in the Kammanassie Mountains). Soils are generally shallow (0.2–0.4 m), mostly with over 50% rock cover, and are of the Mispah and Glenrosa Forms.

Grahamstown Mesotrophic Grassy Fynbos (Type Ge2)

Stratification: 32 to 56.

Formation: Low to mid-high, closed, ericaceous shrubland (Fig. 23).

Differentiating features: This type is easily distinguished from other types of Grassy Fynbos by the high cover of Ericaceae (>50%). In some cases the dense ericaceous canopy excludes the development of a graminoid layer. If restioid cover is high (e.g. 50%) then grass cover must also be high if a stand is to be included in Grahamstown Grassy Fynbos. Less than 10% grass and restioid cover is also permitted in Grahamstown. Relatively distinctive for the Grahamstown Type are microphyllous geophytes. Forbs may be high in cover (>10%), a feature also of Vaalvlei Gm. Pubescent forbs are especially characteristic of the Sundays Gm and Grahamstown Types.

FIG. 23.—Grahamstown Mesotrophic Grassy Fynbos surrounded by invasive *Pinus pinaster*. In this example, 70% cover is contributed by *Erica demissa*. The understorey is mainly *Themeda triandra* and *Restio triticeus*. Near Grahamstown, c. 800 m.

Two forms of Grahamstown Grassy Fynbos can be recognized. In the extreme east there are forms in which the grasses are predominantly C_4 species. Further to the west (e.g. Kammanassie Mountains) there are facies in which the grasses are predominantly C_3 species. In these latter areas the fynbos is mostly not Grassy Fynbos, the Grassy Fynbos examples being restricted to shalebands.

Apart from the high cover of usually C_4 grasses, other features which distinguish Grahamstown from most Ericaceous Fynbos types include a low sedge and geophyte cover (0–5%), single-species dominance within the Ericaceae, the occasional presence of deciduous shrubs (*Montinia caryophyllacea*), proteoids such as *Protea neriifolia* and *Leucadendron salignum*, and pubescent forbs, the more constant presence of microphyllous geophytes and pubescent shrubs, the often high cover of orthophyllous shrubs (>10%), and the notable lack of evergreen meso-macrophyllous geophytes.

Floristics: In the east, *Erica decipiens*, *E. demissa*, *E. copiosa*, *Themeda triandra*, *Restio triticeus*, *Helichrysum cymosum* and *Helichrysum petiolatum*. In the more western area floristics are variable: *Erica* spp., *Pentameris macrocalycina* and other C_3 grasses, *Restio sejunctus*, *Elegia juncea* and *Hypodiscus albo-aristatus*.

Distribution: Predominantly E, with occasional examples in the SI (Fig. 20).

Environment: Grahamstown Type usually occurs on deep, mostly rock-free soils derived from quartzites (soil depths of 0.3–1.0 m and rock cover mostly below 30%). When Grahamstown is recorded in the more western areas then it is found on shalebands. Many of the soils on which Grahamstown occurs differ markedly from most fynbos soils, and are of the Nomanci, Magwa, Oakleaf, Glenrosa or Mispah Forms. Mean annual rainfall ranges from 600 mm to 1 000 mm.

Synonymy: Grahamstown is close to Martin & Noel's

(1960) tall heath or their *Erica demissa*–mixed heath alliance.

Discussion

Relationships to other communities

Grahamstown and Mannetjiesberg Mesotrophic Grassy Fynbos are particularly close to Afromontane Fynbos. This is especially the case with those facies of Grahamstown Grassy Fynbos which have less than 10% cover of restioids. These facies should probably not have been included in Grassy Fynbos but there were too few plots to justify another major vegetation group. On the other hand, Grahamstown shows close structural relationships with Ericaceous Fynbos which occurs further to the west. Grahamstown and Ericaceous Fynbos also share a similar environment. In their respective landscapes in the east and west they both occur on the mesic sites — usually on deeper soils, at higher altitudes, and on the south aspects.

Mannetjiesberg Type occupies a position between non-ericaceous Afromontane Fynbos on the one hand and Oligotrophic Asteraceous Fynbos on the other. The communities of this continuum share a dominance by non-ericaceous ericoids, and environmentally they have similar mean annual rainfall (500–1 000 mm) and similar soil depths (0.3–0.4 m). In the east a structurally similar non-fynbos community, Elandsberg Grassy Shrubland (this has more grass and less ericoid cover), occurs on the more xeric sites, whereas in the west Oligotrophic Asteraceous Fynbos is replaced by other fynbos communities on the more xeric sites (e.g. Dry Asteraceous Fynbos).

Dry Grassy fynbos is roughly equivalent to Mesotrophic Asteraceous Fynbos of more western areas except in the relative proportions of restioids and grasses. Vaalvlei Gm is close to being included in Mountain Fynbos.

Chapter 9

Asteraceous Fynbos (Series A)

The differentiation of the Asteraceous Fynbos Series is set out in Table 14 (excluding the Talus Asteraceous Subseries) and Key 7. A differentiated table for the Talus Asteraceous Fynbos Subseries accompanies the description of that Subseries (see Table 15).

Dry Asteraceous Fynbos (Subseries Ad)

Stratification: 32 occasionally 34, 43 (see Fig. 4, p.8).

Formation: Low, sparse to open, leptophyllous shrubland occasionally with mid-high, sparse shrubs.

Differentiating features: The major character which sets Dry Asteraceous Fynbos apart from the other subseries is the low total cover (usually less than 50%). Non-ericaceous ericoid shrubs are prominent (>10%, up to 45%), but this is also a feature of Oligotrophic and Talus Asteraceous Fynbos. Dry Asteraceous Fynbos lacks the features that are characteristic of the other subseries of Asteraceous Fynbos, e.g. Ericaceae, >20% restioids, >30% graminoids, and >1% coarse aphyllous sedges. The attribute of having >10% fleshy-leaved shrubs is a more constant feature of Dry Asteraceous Fynbos than the other subseries and it is only in Dry Asteraceous Fynbos that succulents can occur with >5% cover. Grasses may occur with as much cover as restioids, and proteoids are characteristically absent.

Distribution: Mostly SI, I & NW (Fig. 24).

Environment: Of the 4 subseries of Asteraceous Fynbos, it is Dry Asteraceous Fynbos which occurs under the lowest rainfall (450 mm annual average). Soils are usually shallow (mostly 0.1–0.3 m deep), rocky (mostly over 60% cover), and are almost always derived from T.M. or Witteberg quartzites. Dry Asteraceous Fynbos can occasionally be found on deeper, colluvial soils derived from quartzites. Most soils are of the Mispah Form, with a few being of the Glenrosa and Clovelly Forms.

Synonymy: Taylor (1978) and Kruger (1979a) provide general descriptions of Dry Asteraceous Fynbos in their discussions of Arid Fynbos. Phytosociological accounts can be found in Bond (1981; e.g. *Phylica axillaris*–*Felicia filifolia* Community, *Passerina obtusifolia*–*Felicia filifolia*–*Pentaschistis eriostoma* Community) and in Taylor & Van der Meulen (1981, Community I).

Katbakkies Dry Asteraceous Fynbos (Type Ad1)

Differentiating features: The Katbakkies Type is distinguished from Sebrafontein Ad by having a higher cover of fleshy-leaved shrubs (more constantly >20%), elytopappoids (>5%) and grasses (mostly 5–20%) (Fig. 25). Stem succulents and deciduous shrubs have higher constancies in the Katbakkies Type.

Floristics: *Elytropappus rhinocerotis* (very occasionally *E. adpressus*), *Pentaschistis eriostoma* (and occasionally other C₃ grasses, e.g. *Merxmuellera arundinacea*, *Erharta ramosa*, *Pentaschistis colorata*), *Passerina glomerata*, *P. vulgaris* (or other ericoids e.g. *P. obtusifolia*, *Phylica lanata*, *Phylica lachneaeoides*, *Felicia filifolia*, *Scyphogyne rigidula* (the Ericaceae present are usually of the minor genera); *Othonna coronopifolia*, *Euryops erectus*, *Muralia scoparia*, *Agathosma recurvifolia*, *Anthospermum* sp. and *Relhania* spp. (e.g. *R. squarrosa* and *R. sedifolia*).

Distribution: Mostly SI & I (Fig. 24).

Environment: When Katbakkies and Sebrafontein Ad Types occur on the same transect, then it is Katbakkies that is usually found under more xeric conditions (e.g. at lower altitudes). It appears that on heavily grazed areas, Katbakkies replaces Sebrafontein.

Sebrafontein Dry Asteraceous Fynbos (Type Ad2)

Differentiating features: Unlike Katbakkies, the Sebrafontein Type often has >10% ericoid Asteraceae. The attributes of more than 10% restioids and fine aphyllous sedges are not a feature of Katbakkies, but link Sebrafontein with all the other types of Asteraceous Fynbos (Fig. 26).

Floristics: *Metalasia muricata*, *Hypodiscus striatus*, *Canamois dregei*, *Thamnochortus* sp. nr. *T. argenteus*, *Pentaschistis eriostoma*, *Felicia filifolia*, *Passerina* spp., *Phylica* spp., *Diosma prama*, *Ruschia* sp., *Elytropappus gnaphaloides* and *Aspalathus sceptrum-aureum*.

Distribution: NW & SI (Fig. 24).

Environment: See Katbakkies Ad. Sebrafontein, unlike Katbakkies, is not a feature of the Interior mountain region. This is either because the mountains of this

KEY 7.—Key to the types of Asteraceous Fynbos

1. *Protea nitida* absent
 - 1.1 >10% relative cover elytropappoids
 - unless: >10% non-ericaceous ericoids; or <40% total cover; or >5% succulents and <70% total cover (Katbakkies Dry Asteraceous Fynbos) Witteberg Mesotrophic Asteraceous Fynbos
 - 1.2 >5% relative cover elytropappoids
 - unless: >70% total cover or >10% proteoids Katbakkies Dry Asteraceous Fynbos
 - 1.3 >10% tall microphyllous non-proteoid shrubs Oukraal Oligotrophic Asteraceous Fynbos
 - 1.4 >10% Bruniaceae or >20% evergreen geophytes Fisantkraal Oligotrophic Asteraceous Fynbos
 - 1.5 >10% Ericaceae, >10% grass; or >20% Ericaceae, >5% grass Bantamskop Mesotrophic Asteraceous Fynbos
 - 1.6 <5% succulents and one of the following: >20% grass; or >10% grass and >60% total cover; or >5% grass, <10% restioids and >60% total cover Beakos Mesotrophic Asteraceous Fynbos
 - 1.7 Non-lobed-leaved proteoids >1 m or >10% low proteoids; usually 20–50% restioids
 - unless <40% total cover (Sebrafontein Dry Asteraceous Fynbos) Wuppertal Oligotrophic Asteraceous Fynbos
 - 1.8 >30% restioid cover, or >70% total cover, or >20% restioid cover; usually <1% succulents
 - unless >5% fleshy-leaved shrubs or stem spinescence present Algeria Oligotrophic Asteraceous Fynbos
 - 1.9 <60% total cover, succulents present (up to 20%), restioids 10–30% Sebrafontein Dry Asteraceous Fynbos
2. *Protea nitida* present
 - 2.1 >10% elytropappoids; or <30% grass, <5% restioids, >70% shrubs Gydo Talus Asteraceous Fynbos
 - 2.2 >20% grass Rooiberg Talus Asteraceous Fynbos
 - 2.3 <40% total cover of Ericaceae plus restioids Uitkyk Talus Asteraceous Fynbos
 - 2.4 Not as above Brandwag Talus Asteraceous Fynbos

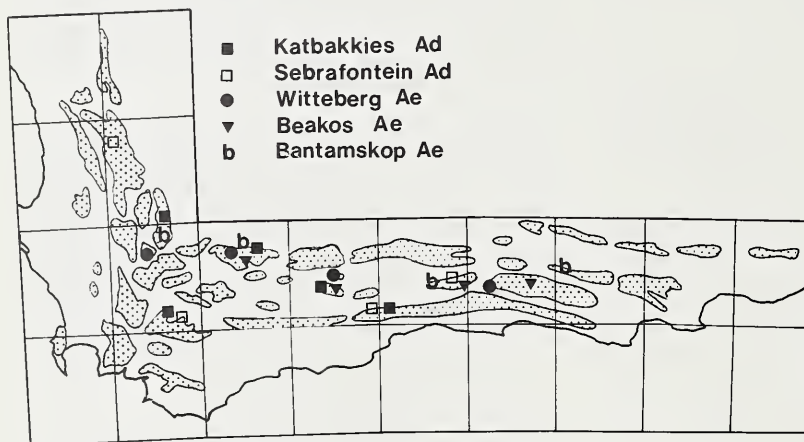


FIG. 24.—Distribution of Dry (Ad) and Mesotrophic (Ae) Asteraceous Fynbos.



FIG. 25.—Katbakkies Dry Asteraceous Fynbos on Witteberg quartzites. The shrubby nature of Katbakkies, in this case mostly due to *Elytropappus rhinocerotis* (the pale, finely branched shrub), is shown. Some of the 'shrubs' are coarse restioids (*R. marlothii* in the centre foreground—dark). Katbakkies Pass, c. 1300 m.

FIG. 26. — Sebrafontein Dry Asteraceous Fynbos on shallow rocky soils. The characteristically low cover is shown. The scattered tall restioids are *Cannomois dregei*. Jonaskop, Rivier-sonderendberge, c. 600 m.



region present more xeric conditions, or because soils are more fine-textured (being derived from the Witteberg Group), or because these areas are not incorporated into State Forest Land and are therefore open to heavy grazing.

Mesotrophic Asteraceous Fynbos (Subseries Ae)

Differentiating features: Grass cover is usually over 10% in Mesotrophic Asteraceous Fynbos and, if it is lower, then there is high relative cover of elytropappoids (>10%) or >20% Ericaceae. Grass cover is seldom below 5% and unlike Dry Asteraceous Fynbos, total cover is mostly >50%. Talus Asteraceous Fynbos usually also has high grass cover, but the presence of *Protea nitida* in this other subseries provides an easy distinguishing character.

Distribution: Mostly I & SI (Fig. 24).

Environment: Mesotrophic Asteraceous Fynbos is separated from Oligotrophic Asteraceous Fynbos by the usual environmental features that separate other grassy communities from less grassy communities, i.e. Mesotrophic Asteraceous Fynbos is found on finer-textured soils and in areas where summer rainfall is more pronounced. Thus it is more a feature of the more eastern mountains (Southern Interior Mountain Region as opposed to the North-Western, Central and South-Western Mountain Regions) and it is more a feature of the soils derived from the Witteberg Group. Annual rainfall averages 600 mm and altitude 1 400 m.

Witteberg Mesotrophic Asteraceous Fynbos (Type Ae1)

Stratification: 21 to 34.

Formation: Low, open to mid-dense, leptophyllous shrubland occasionally with mid-high, sparse shrubs (usually proteoids) and with a variable graminoid understorey (sparse to open grasses and/or restioids).

Differentiating features: Witteberg is distinguished from other types of Mesotrophic Asteraceous Fynbos by having over 10% elytropappoids (up to 40%), and a high constancy of stem spinescence. As such, it is similar to Katbakkies Ad, but Katbakkies usually has a lower elytropappoid cover, a lower total cover (not normally above 60%), and never has Ericaceae above 5%. In Witteberg Ericaceae vary from 0–40% and, unlike Katbakkies, ericoid non-Ericaceae are below 10% cover. Grass cover varies from 1–30% (usually 5–20%), restioid cover varies from 1–60% (usually 5–30%), and sedges are mostly below 5%. Low sedge cover is a feature also shared with Beakos Ae, with >5% sedges being more common in Bantamskop Ae. Low nanophyllous proteoids are often present.

Floristics: The main high-constancy taxa which achieve dominance are Ericaceae (often *Scyphogyne rigidula*) and *Elytropappus rhinocerotis*, and to a lesser extent *Hypodiscus neesii* and *Pentaschistis eriostoma*. Other dominants include *Relhania* spp. (e.g. *R. corymbosa*, *R. speciosa*), *Merxmuellera stricta*, *Cliffortia ruscifolia* and *Leucadendron salignum*.

Distribution: I & SI (Fig. 24).

Environment: Witteberg and Bantamskop Ae are both especially characteristic of Witteberg quartzites. However, Bantamskop may be found on T.M. quartzites and Witteberg is also found on Bokkeveld shales and quartzites, and on silcrete. The soils of Witteberg and Bantamskop are mostly fine-textured, slightly more so in Witteberg (fine-sandy loams to clay loams). Witteberg soils are of Mispah, Glenrosa and Swartland Forms, whereas the soils of Bantamskop are mostly of the Mispah Form. Soil depth varies from shallow to deep in Witteberg (0.1–0.6 m), but is usually shallow in Bantamskop (0.1–0.3 m). Mean annual rainfall is mostly below 500 mm in Witteberg, but it may be higher (e.g. 1 200 mm) if the soils are particularly fine textured (sandy clay loam).



FIG. 27.—Bantamskop Mesotrophic Asteraceous Fynbos on steep south-facing slopes on the Witteberg Mountains. The major species present are *Salaxis axillaris*, *Restio* sp. and *Pentastichis eriostoma*, with *Protea laurifolia* being the emergent. Bantamskop, c. 1 300 m.

Beakos Mesotrophic Asteraceous Fynbos (Type Ae2)

Stratification: 32, 43.

Formation: Low, open to mid-dense, graminoid leptophyllous shrubland (graminoids being restioids and grasses).

Differentiating features: Unlike the other two types of Mesotrophic Asteraceous Fynbos, Beakos often has over 60% relative cover of graminoids, with grasses having 10–40% cover (usually 10–20%) and restioids usually having 15 to 35% cover. Grass cover may be as low as 5–10% but in these cases restioids are <10%. Ericaceae are of lower constancy and cover than in Witteberg Ae and Bantamskop Ae. Other features which show this pattern are low mostly nanophyllous proteoids, mesophyllous proteoids, non-pubescent forbs, net-veined geophytes, and coarse aphyllous sedges.

Floristics: The only truly constant dominant species is *Pentastichis eriostoma*. Other dominants include *Passerina* spp. (e.g. *P. pendula*, *P. obtusifolia*), *Cannomois dregei*, *Hypodiscus striatus*, *Felicia filifolia*, *Diosma prama*, *Stoebe* spp. (e.g. *S. incana* and *S. microphylla*), *Merxmuellera* spp. (e.g. *M. stricta* and *M. arundinacea*), *Agathosma* spp., *Phyllica* spp. and various Restionaceae.

Distribution: SI & I (Fig. 24).

Environment: In general, it appears that Beakos occurs on more coarse-textured soils than those on which Witteberg and Bantamskop are found. Beakos is often found on north aspects, or on local south aspects that are on the north slopes of the mountains. In an altitudinal sequence, Beakos may often occur between Dry Asteraceous Fynbos at the lower altitudes and Restioid Fynbos at the higher altitudes. Soil depths are shallow (0,1–

0,4 m), and soils are mostly derived from T.M. quartzites (occasionally Witteberg quartzites and silcretes) and are mainly of the Mispah Form.

Bantamskop Mesotrophic Asteraceous Fynbos (Type Ae3)

Stratification: 21 to 42.

Formation: Low, mid-dense, ericaceous shrubland with an open to mid-dense, grass and restioid understorey (Fig. 27).

Differentiating features: The major diagnostic feature is high cover (>20%) of Ericaceae. Witteberg Ae occasionally has a high cover of Ericaceae but, if so, then it also has over 10% elytropappoids. Both Witteberg and Bantamskop often have over 5% low (<0,1 m) grasses, a character not common in other types of Asteraceous Fynbos. Mat proteoids tend to have their highest constancy in Bantamskop. Grass cover usually varies from 5 to 40%.

Floristics: Apart from *Elegia parviflora* and *Pentastichis eriostoma*, there are few other dominants which are constant. Ericaceae are constant, but *Salaxis axillaris* and *Scyphogyne rigidula* are the only species which are relatively constant. Other dominants include *Restio* sp., *R. fruticosus*, *R. sejunctus*, *Thamnochortus* sp. nr. *T. argenteus*, *Willdenowia teres*, *Pentameris dregeana*, *Pentastichis curvifolia*, *Ehrharta ramosa* and *Stoebe incana*. In the east, a C₄ facies of Bantamskop was recorded; it was dominated by *Themeda triandra* and *Erica* sp. and cf. *E. pectinifolia*.

Distribution: I & SI (Fig. 24).

Environment: Bantamskop usually occurs on the high altitude (c. 1 300 m) south aspects of the interior mountains. See Witteberg Ae for further discussion.

Oligotrophic Asteraceous Fynbos (Subseries Ao)

Differentiating features: In general, restioid cover is higher in Oligotrophic Asteraceous Fynbos than in Mesotrophic Asteraceous Fynbos, and is usually over 20%. If restioid cover is >30% in Mesotrophic Asteraceous Fynbos, then grass cover is also high (>10%). Restioids in the 0,5–1,0 m height class have a higher cover in Oligotrophic and Talus Asteraceous Fynbos than in the other subseries, and sedges, in particular narrow-leafy sedges, are relatively characteristic of these two subseries. Ericaceae are usually below 10% in Oligotrophic Asteraceous Fynbos and if higher, then they are always of the minor ericaceous genera (e.g. *Salaxis* and *Scyphogyne*). Non-ericaceous ericoids often have >10% cover, this also being a feature of Dry and Talus Asteraceous Fynbos.

Distribution: Mostly NW, C & SI (Fig. 28).

Environment: Altitude averages 1000 m and annual rainfall averages 900 mm. Soils are relatively deep in Oligotrophic Asteraceous Fynbos (0,4 m), unlike the soils in Dry and Mesotrophic Asteraceous Fynbos and therefore this subseries is somewhat akin to Talus Asteraceous Fynbos (soil depths of 0,5 m). Oligotrophic Asteraceous Fynbos is found on soils derived from T.M. quartzites (only occasionally from Witteberg quartzites). See Mesotrophic Asteraceous Fynbos for further details.

Algeria Oligotrophic Asteraceous Fynbos (Type Ao1)

Stratification: 32, 34, 43.

Formation: Low to occasionally mid-high, mid-dense to closed, restioid, leptophyllous shrubland.

Differentiating features: Unlike all other types of Asteraceous Fynbos, Algeria appears to have a high constancy of stoeboids and, to a lesser extent, climbers. There is a high constancy of meso-macrophyllous geophytes, but this is also a feature of Fisantkraal Ao. Grass cover is higher in Algeria (usually 5–10%) than in the following type, Wuppertal.

Floristics: Of the dominants only the following 4 species

occurred in more than 1 of the 14 plots: *Metalasia muricata*, *Stoebe saxatilis*, *Restio ocreatus*, *R. gaudichaudianus*. Other dominants include *S. plumosa*, *M. gnaphalodes*, *Elytropappus gnaphaloides*, *E. scaber*, *Phyllis villosa*, *P. lachneaeoides*, *P. purpurea*, *Passerina glomerata*, *P. obtusifolia*, *Felicia filifolia*, *Restio sieberi*, *R. virgeus*, *Willdenowia sulcata*, *Leptocarpus vimineus*, *Tetraria ustulata*, *Pentaschistis eriostoma* and *Ehrharta ramosa*.

Distribution: Mostly NW & C (Fig. 28).

Environment: Algeria occurs at altitudes of 400–1500 m, under a rainfall averaging from 300 mm to 1400 mm p.a., and it usually occurs on shallow soils (<0,4 m) with a high rock cover (>65%). Soils are almost always of the Mispah Form.

Wuppertal Oligotrophic Asteraceous Fynbos (Type Ao2)

Stratification: 43, 32, 34, 21.

Formation: Low, mid-dense to closed, restioid, leptophyllous shrubland usually with a sparse or very sparse, proteoid overstorey (Fig. 29).

Differentiating features: There are no features that are restricted to this type of Asteraceous Fynbos relative to other types of Asteraceous Fynbos. However, Wuppertal is distinguished from Algeria Ao by having Ericaceae and proteoids. A high cover of lobed-leaved proteoids (>10%) and a high cover of non-ericaceous ericoids (over 30%) are low-constancy features of the Wuppertal Type that do not appear to be found in Algeria.

Floristics: Only *Hypolaena purpurea*, *Hypodiscus striatus*, *Hypodiscus neesii*, *Restio fruticosus* and *Elytropappus glandulosa* are dominants in more than one plot. *Protea laurifolia* is often the emergent proteoid, other emergents being *P. lorifolia*, *P. repens*, *P. scolymocephala*, *Cliffortia ruscifolia*, *Leucadendron rubrum*, *L. pubescens* and *L. teretifolium*. Other dominants include *Phyllis* spp. (e.g. *P. leipoldtii*, *P. villosa*, *P. stenantha*, *P. lachneaeoides*), Rutaceae (e.g. *Coleonema* spp., *Euchaetis vallis-simiae*, *Acnadenia* sp.), *Passerina obtusifolia*, *Restio gaudichaudianus*, *Cannomois dregei*, *R. hystrix*, *Montinia caryophyllacea* and *Leucadendron salignum*.

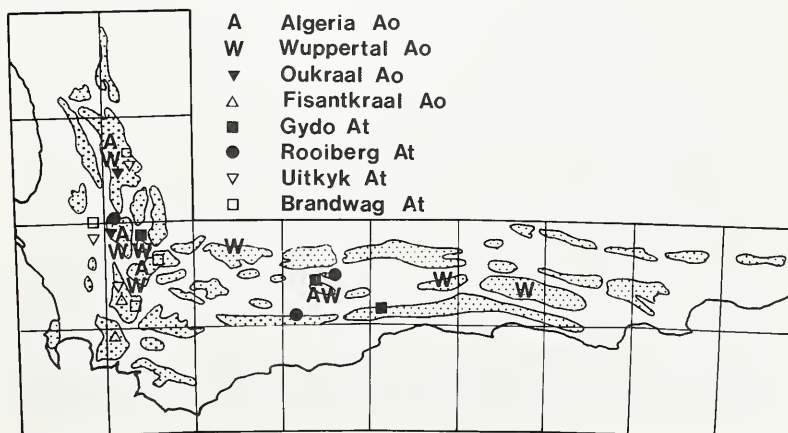


FIG. 28.—Distribution of Oligotrophic (Ao) and Talus (At) Asteraceous Fynbos.



FIG. 29.—Wuppertal Oligotrophic Asteraceous Fynbos. *Protea laurifolia* is the emergent and the shrubs are mainly *Phylica villosa*, *Stoebe saxatilis* and *Met-alasia muricata*. Voorstehoek, Cedarberg, c. 1 100 m.

Distribution: NW, C & SI (Fig. 28).

Environment: Wuppertal occurs at various altitudes (500–1 600 m) and under mean rainfall from 400 mm to 1 000 mm p.a. Relative to Algeria the environment of Wuppertal is one of the following: soils are either deeper or less rocky (and soils are not exclusively of the Mispah Form), aspects are more southerly, slopes are less steep, or altitudes are lower. It is Wuppertal which occupies the sites which permit proteoids to be present. Note, however, that it is likely that peculiar fires (e.g. fires in the wrong season) could easily convert Wuppertal to Algeria. Wuppertal and Algeria both have soils with coarse textures (mostly medium sands and medium loamy sands).

Oukraal Oligotrophic Asteraceous Fynbos (Type Ao3)

Stratification: 43, 66.

Formation: Low, closed shrubland with mid-high to tall, sparse, large-leaved, non-proteoid shrubs or tall, open shrubland (with some large-leaved, non-proteoid shrubs) with a low to mid-high, open, shrub understorey (Fig. 30).

Differentiating features: Unlike other types of Asteraceous Fynbos, this type has over 10% cover of microphyllous non-proteoid shrubs, and often has over 20% of nanophyllous non-proteoid shrubs. It is also taller than most other types of Asteraceous Fynbos.

Floristics: *Phylica oleifolia*, *Indigofera frutescens*, *Heeria argentea*, *Stoebe intricata* and *Restio gaudichaudianus*.

Distribution: NW (Fig. 28).

Environment: The important environmental distinction of Oukraal is its location on fire-protected sites (and this

is probably one of the reasons why large-leaved non-proteoid shrubs are present in the community). Fire protection is usually afforded by large boulders (e.g. of >1.5 m diameter) or by large outcrops of bedrock. The plots representing this type were recorded at low altitudes (c. 700 m). In environmental and vegetation terms, Oukraal is intermediate between Mitchell Thicket which occurs on screes with a higher cover of large boulders, and Talus Asteraceous Fynbos which is generally found on colluvial slopes with a high cover of smaller rocks.

Fisantkraal Oligotrophic Asteraceous Fynbos (Type Ao4)

Stratification: 32, 34, 63.

Formation: Low to mid-high, closed, leptophyllous shrubland.

Differentiating features: This is a variable type which is essentially differentiated by the presence of more mesic features than those occurring in other types of Asteraceous Fynbos e.g. >20% evergreen geophytes, >20% orthophyllous shrubs, >20% leafy sedges, or the presence of plumose restioids and Bruniaceae. Unlike all other types of Asteraceous Fynbos it appears to lack leaf spinescence.

Floristics: *Cliffortia polygonifolia*, *Aristea thyrsifera*, *Watsonia* sp., *Restio sieberi*, *Brunia nodiflora*, *Tetraria flexuosa*, *Cliffortia* sp. cf. *C. atrata*?, *Anthospermum aethiopicum*, *Corymbium* sp., *Hippia pilosa* and *Pentastichis steudelii*.

Distribution: C & SW (Fig. 28).

Environment: Fisantkraal is characterized by occurring under high rainfall conditions (mean >1 600 mm p.a.). Soils are often deep (e.g. 0.8 m) and may be fine textured. Fisantkraal represents the high-rainfall type of Asteraceous Fynbos. For various reasons (e.g. great soil depth,

high clay content, dry north slopes), Restioid or Ericaceous Fynbos is unable to develop, although the rainfall conditions are suitable. Soils are of Mispah, Glenrosa or Swartland Forms.

Talus Asteraceous Fynbos (Subseries At) (Table 15)

Differentiating features: The essential diagnostic character of Talus Asteraceous Fynbos is the presence of *Protea nitida*. Its presence in turn creates other differentiating characters such as the presence of vegetation in the 2–5 m height class. Very few other types of Asteraceous Fynbos have vegetation as tall. Other characters that tend to a constancy higher in Talus Asteraceous Fynbos than in the other subseries are lobed-leaved proteoids and microphyllous non-proteoid shrubs. Geophytes tend to have a higher cover (>10%) in Talus Asteraceous Fynbos, and evergreen geophytes are diagnostic for Talus and Oligotrophic Asteraceous Fynbos. Leafy sedges also show slightly higher cover and constancy in Talus Asteraceous Fynbos. Of all the subseries, Talus Asteraceous Fynbos tends to have the highest total cover (>80%). The types of this subseries can be identified by matching the understorey with various other types of fynbos. The understorey of Gydo At is similar to Witteberg Ae, that of Rooiberg At is similar to Beakos Ae, that of Uitkyk is similar to Oligotrophic Asteraceous Fynbos and the understorey of Brandwag At is similar to Restioid Fynbos.

Distribution: Mostly NW & C but also characteristic of SI & SC (Fig. 28).

Environment: Soils are relatively deep in Talus Asteraceous Fynbos (mostly 0.4–0.6 m) and rock cover varies from 60–80%. The soils are characteristically of the Glenrosa, Oakleaf, Hutton and Clovelly Forms. Only one of the types, Gydo At, is characteristic of soils derived from non-quartzites, and in general, this series is a community of relatively stabilized scree slopes (with

the common rock size being less than 50 cm in diameter). Soil depth is the characteristic that separates this subseries from other subseries of Asteraceous Fynbos. The lower altitudes (750 m) in this subseries, relative to the other subseries, probably relate to the association of deep soils with low altitudes.

Synonymy:

- Bond (1981): *Protea nitida* Community, *Protea nitida*–*P. repens* Community;
 Boucher (1978): *Protea*–*Tetraria* Dry Short Fynbos;
 Kruger (1979a): Tall broad-sclerophyllous shrubland or open shrubland with heathland;
 McKenzie *et al.* (1977): *Restio gaudichaudianus*–*Lobostemon glaucophyllus* Community;
 Taylor (1978). Waboomveld;
 Taylor & Van der Meulen (1981): Waboomveld;
 Werger *et al.* (1972): *Protea nitida*–*Rhus angustifolia* Community (i.e. '*Protea arborea*–*Rhus angustifolia* Community').

Gydo Talus Asteraceous Fynbos (Type At1)

Stratification: 43.

Formation: Low to mid-high, closed, leptophyllous shrubland with a very sparse, proteoid overstorey and an open, restioid and grassy understorey.

Differentiating features: The high cover of elytopappoids (>10%) is the key differential feature, although there is a facies in which high shrub cover (>70%) without elytopappoids is combined with low grass cover (<10%), low restioid cover (e.g. 1%) and with succulents up to 5%. Total cover is generally higher in Gydo than in the other types of Talus Asteraceous Fynbos and a number of characters that are found in the other types appear to be absent from Gydo: ericoid-leaved Asteraceae, evergreen geophytes and rosette forbs.



FIG. 30.—Oukraal Oligotrophic Asteraceous Fynbos. This tall stand of shrubs in a fire-protected rocky area, consists mainly of *Indigofera fruticosa* and *Phyllea oleacea*. Near Clanwilliam, c. 600 m.

TABLE 15.—Differentiated table for Talus Asteraceous Fynbos. See Table 8 for notes on characters and conventions used

	Talus Asteraceous Fynbos																
	Gydo			Rooiberg			Uitkyk				Brandwag						
	Plot numbers																
	150	345	442	423	039	488	102	103	068	009	014	002	099	098	038	131	100
† Elytropappoid	3	6	1														*
# Total cover >8	9		9														
Grass >1			2	2	2	2											
† Aphyllous >*				0		0											0
Grass, 0,25–0,5 m >0			1	2	1	1											
† Proteoid, >1 m >*	2	0	0	1	0	1								1			0
† Microphyllous, non-proteoid, 2–5 m							0			1	*						
† Nanophyllous, non-proteoid, >1,5 m			0					*	*	*							
† Ericoid-leaved (Rhamnaceae, Thymelacaceae) >0									1	1		1					
† Lobed-leaved, non-proteoid					*	0	*	+	0	*	*	*				*	
Restioid, 1–1,5 m			*	*	*			0	0	*		0					
# Total cover, 2–5 m >*	1		0				1			1							
† Leptophyllous, broad (non-fleshy)	3	+		*	0	1	*		1	2	*						
† Woody plant, non-proteoid >5	9	8			6		6		7	8							
Fern, pinnate-leaved	+		+	+			+		*	+							
Grass, 0,25–0,5 m >*		0	1	2	1	1	0		0		0				0		
† Woody plant, 1–1,5 m >*	3	0	2	1	1	1	4	1	1	2		1		1			
# Total cover, 1,5–2 m >*	1					0				1	1						
Restioid, 0,25–0,5 m >1											2		2	4	4	3	3
Restioid >3						4					5	4		4	4	5	4
# Total cover, 0,25–0,5 m >5											7		6		7	7	
† Ericaceae >*										0	0	1	1				5
Sedge, leafy (wide)											0	*					0
† Proteoid, <1 m (non-mat)	*						+					1	*	1	*	*	*
† Proteoid, mat															+		*
Grass, aphyllous						0	*		0		*	+	+			*	
Geophyte >0					1	1					1	1			1		
Sedge >0		1				1					1					1	1
† Ericoid-leaved (Asteraceae) >*				2	0	0			0		0	0	1	1	0		
Restioid, 0,5–1 m >*				1	0	3	2	2	0	1	3	2				1	0
Geophyte, evergreen	0				1	1	+	+	+	+	1		1		1	0	*
Forb, rosette				*			*	+	+	+	*		*	*	+	*	*
† Microphyllous, non-proteoid					*	0	0	+	*	2	*	*	*	*	*	*	*
† Proteoid, nanophyllous, <1,5 m (non-mat)	0	*	*	0	*	*						*		3	*	*	*

† = woody plants; # = woody and herbaceous plants; 'no symbol' = herbaceous plants; + = less than 1% cover; * = 1–5%; 0 = 5–10%; 1 = 10–20%; 2 = 20–30%; 3 = 30–40%; 4 = 40–50%; 5 = 50–60%; 6 = 60–70%; 7 = 70–80%; 8 = 80–90%; 9 = greater than 90%.

Floristics: *Elytropappus rhinocerotis*, *E. adpressus*, *Restio gaudichaudianus*, *Cliffortia ruscifolia*, *Themeda triandra*, *Pentaschistis colorata*, *Montinia caryophyllacea* and *Restio* sp. The emergents always include *Protea nitida*.

Distribution: NW, SI & SC (Fig. 28).

Environment: Of all Talus Asteraceous Fynbos, Gydo is differentiated by occurring on fine-textured soils (e.g. sandy clay loams). The soils are usually not derived from quartzites. Mean annual rainfall ranges from 400 mm to 900 mm.

Rooiberg Talus Asteraceous Fynbos (Type At2)

Stratification: 43.

Formation: Low to mid-high, closed, graminoid, leptophyllous shrubland with a very sparse, proteoid over-

storey. The graminoids always include grasses but restioids may have high cover (up to 50%).

Differentiating features: The greater than 20% grass cover is the key differentiating feature. Also differential are aphyllous shrubs. Proteoids contribute more than 5% cover in Rooiberg and Gydo.

Floristics: *Hypodiscus striatus*, *R. gaudichaudianus*, *Pentaschistis eriostoma*, *Elytropappus scaber*, *Stoebe aethiopica*, *Phylica rubra*, *Leucadendron salignum*, *Montinia caryophyllacea*, *Restio fruticosus*, *Themeda triandra*, *Aristida junciformis* and *Lanaria lanata*. *Protea nitida* is the emergent.

Distribution: NW, SI & SC (Fig. 28).

Environment: Rooiberg has a similar rainfall to Gydo, but it does not occur on particularly fine-textured soils. It often occurs on local south aspects on north slopes, and as such is similar to Beakos which also has a high grass cover.



FIG. 31.—Uitkyk Talus Asteraceous Fynbos. The scattered emergent *Protea nitida* is clearly shown. The dominants in the understorey are *Phylica villosa*, *Willdenowia luceana*, *Cannomois aristata* and *Montinia caryophyllacea*. Uitkyk Pass, Cedarberg, c. 700 m.

Uitkyk Talus Asteraceous Fynbos (Type At3)

Stratification: 43.

Formation: Low to mid-high, closed, restioid, leptophyllous shrubland with a very sparse, proteoid overstorey (Fig. 31).

Differentiating features: Tall microphyllous and nanophyllous shrubs are characteristic of Uitkyk and lobed-leaved non-proteoid shrubs tend to be more constant in this type than in the other types. Taller restioids (>1 m) tend to be found in Uitkyk and Rooiberg At and the following features are found in Gydo At, Rooiberg and Uitkyk, but are absent from Brandwag At: >60% woody non-proteoid shrubs, broad leptophylls, ferns (e.g. *Mohria caffrorum*, *Cheilanthes eckloniana*), >5% above 1,5 m, and 5–30% above 1 m (usually less than 5% in Brandwag). Moreover, >10% sedges and >10% geophytes are features of Rooiberg and Brandwag, but are absent from Uitkyk.

Floristics: *Maytenus oleoides*, *Montinia caryophyllacea*, *Passerina vulgaris*, *Cliffortia ruscifolia*, *Restio gaudichaudianus*, *Phylica villosa*, *Cannomois aristata*, *Anthospermum aethiopicum*, *Agathosma bisulca*, *Aspalathus lanata*, *Eriocephalus africanus* and *Phylica lachnaeoides*. *Protea nitida* is always an emergent and *Maytenus oleoides* is often an emergent.

Distribution: NW & C (Fig. 28).

Environment: Uitkyk occurs under more mesic conditions than Gydo and Rooiberg (mean rainfall 800 mm to 1 600 mm p.a.).

Brandwag Talus Asteraceous Fynbos (Type At4)

Stratification: 32.

Formation: Low, closed, restioid, leptophyllous shrubland with a very sparse, proteoid overstorey.

Differentiating features: Unlike other types of this sub-series, Brandwag usually has over 40% cover of restioids, with a high restioid (>20%) and total cover (>60%) in the 0,25–0,5 m height class. >5% Ericaceae, wide-leafy sedges, low proteoids and mat proteoids are also differential. Aphyllous grasses are chiefly found in Brandwag and Uitkyk At.

Floristics: *Restio gaudichaudianus*, *R. filiformis*, *Corymbium* sp., *Montinia caryophyllacea*, *Leucadendron salignum*, *Leucadendron rubrum*, *Stoebe spiralis*, *S. plumosa*, *Elytropappus glandulosa*, *Anthospermum aethiopicum*, *Erica nodiflora*, *E. nudiflora*, *Tetraria ustulata*, *T. cuspidata*, *Phylica excelsa*, *Elegia parviflora* and *Agathosma bisulca*. *Dodonaea viscosa*, *Maytenus oleoides* and *Protea laurifolia* are occasional emergents with *P. nitida*.

Distribution: NW & C (Fig. 28).

Environment: Brandwag is the most mesic type in Talus Asteraceous Fynbos (mean rainfall over 1 000 mm p.a.).

Discussion

The validity of Talus Asteraceous Fynbos (Waboomveld)

Talus Asteraceous Fynbos is one of the few communities in fynbos which has been consistently recognized. Taylor (1963), after pointing out the utility of indicator and easily recognizable species in determining fynbos communities, suggested that Waboom, *Protea nitida*, was sufficiently exclusive and with apparent constant associates to warrant acceptance as an indicator for a specific fynbos community, Waboomveld. In the two previous biome-wide descriptions of fynbos, Waboomveld has been described as a major category of fynbos (Taylor, 1978; Kruger, 1979a).

Although initially sceptical of such a simply-defined community, i.e. defined only on the presence or absence of Waboom, I have come to accept the concept. However, it should be noted that Talus Asteraceous Fynbos includes a range of different types of understorey and a more meaningful concept is obtainable by classifying this subseries into various types, as has been done here. Boucher (1978) and Bond (1981) both record wide variation in the understorey to *P. nitida*: from exclusively fynbos species (Brandwag At) to a predominance of renosterveld species (Gydo At). It should also be noted that *P. nitida* does not always indicate Talus Asteraceous Fynbos. I have placed two of my *P. nitida* plots in Grassland & Grassy Shrubland (Hankey and Seweweeks-

poort), one plot in Clanwilliam Karroid Shrubland, and a number in Proteoid Fynbos. When *P. nitida* is found in Proteoid Fynbos then it is other proteoids which are the dominants (e.g. *P. repens* in Gymanshoek and Thomas Dry Proteoid Fynbos, *P. neriifolia* in Studtis and Swartbos Mesotrophic Proteoid Fynbos). Some workers would probably prefer placing some facies of Gydo At in Renoster Shrubland. Bond (1981) and Boucher (1978) have also recorded *P. nitida* in communities other than their *P. nitida* communities, and furthermore *P. nitida* is not always constant in their *P. nitida* communities (see also Taylor & Van der Meulen, 1981). In my classification, *P. nitida* has to be present for a stand to be classified as Talus Asteraceous Fynbos.

Restioid Fynbos (Series R)

Differentiation between the communities of the Dry Restioid Fynbos and Mesic Restioid Fynbos Subseries (the zonal communities) is by means of Table 16. Classification to types is achieved with the aid of Key 8. The differentiation within the Azonal Restioid Fynbos Subseries is given in Table 17.

Dry Restioid Fynbos (Subseries Rd)

Differentiating features: Dry Restioid Fynbos and Mesic Restioid Fynbos are not clearly differentiated. Tending to a higher constancy in Dry Restioid Fynbos are elytropappoids, lobed-leaved proteoids, microphyllous non-proteoid shrubs, microphyllous geophytes, and >10% non-ericaceous ericoids. Total cover seldom exceeds 80% in Dry Restioid Fynbos, whereas it is often over 80% in Mesic Restioid Fynbos. Unlike Mesic Restioid Fynbos, Dry Restioid Fynbos has a lower constancy of leafy sedges and cover of leafy sedges only occasionally exceeds 5%.

Floristics: *Cannomois dregei*, *Restio sieberi*, *Willdenowia arescens*, *R. virgeus*, *Elytropappus* spp. (e.g. *E. rhinocerotis*, *E. adpressus* and *E. gnaphaloides*), and *Phylica* spp. (e.g. *P. odorata*, *P. rigidifolia*, *P. leopoldtii* and *P. purpurea*) are relatively characteristic as dominants of Dry Restioid Fynbos. *Hypodiscus striatus* and *Elegia parviflora* are often dominants in both Dry Restioid Fynbos and Mesic Restioid Fynbos. Dry Restioid Fynbos has almost no sedge dominants, unlike Mesic Restioid Fynbos.

Distribution: Most mountain regions excluding the E, I & SC Regions (Fig. 32).

Environment: Dry Restioid Fynbos is found under more xeric conditions than Mesic Restioid Fynbos. It either occurs at lower altitudes or it tends to occur in the regions where summer drought is most severe (i.e. in the North-Western Mountain Region). Soil depths average 0,2 m in Dry Restioid Fynbos and soils are almost always of the Mispah Form.

KEY 8.—Key to the types of Restioid Fynbos

1. Seed-regenerating overstorey proteoids present. The proteoids usually included are *Protea laurifolia*, *P. glabra*, *P. repens*, *P. lorifolia*, *P. punctata*, *P. neriifolia* or *P. eximia*. (Note that *Protea magnifica* usually indicates Jonaskop Mesic Restioid Fynbos, and *Leucadendron gandogerii* indicates types other than Kouga and Winterhoek.)
 - unless <50% total cover (Wolfberg Azonal Restioid Fynbos) or >20% grass (Boesmansbos Azonal Restioid Fynbos)
 - 1.1 >10% leafy sedge cover, or >90% total cover, or wide leafy sedges present, or >1% evergreen meso-macrophyllous geophytes (unless elytropappoids also present) Kouga Mesic Restioid Fynbos
 - 1.2 Not as above Winterhoek Dry Restioid Fynbos
2. Sprawling restioids or >30% plumose restioids
 - 2.1 Sprawling restioids Sneekop Azonal Restioid Fynbos
 - 2.2 >30% plumose restioids Crystal Azonal Restioid Fynbos
3. >20% grass
 - unless >20% grass below 0,25 m (Fonteintjesberg Azonal Restioid Fynbos)
 - or >10% grass and one of the following: mat proteoids: or >10% evergreen meso-macrophyllous geophytes; or >30% sedges, >80% restioids
 - 3.1 Mat proteoids present, <10% sedges Langberg Azonal Restioid Fynbos
 - 3.2 >5% leafy sedges or proteoids >1 m or >1% pubescent-leaved shrubs Boesmansbos Azonal Restioid Fynbos
 - 3.3 Usually: 5–30% Ericaceae, 20–40% grass, >20% non-proteoid shrubs, sometimes >40% cover >0,5 m Horingberg Mesic Restioid Fynbos
4. >10% leafy sedges; or >20% sedges; or >20% Ericaceae: or >10% Ericaceae, >50% relative cover graminoids
 - 4.1 >20% coarse aphyllous sedges Wolfberg Azonal Restioid Fynbos (in part)
 - 4.2 Usually <20% shrub cover and, >90% relative cover graminoids or >90% cover graminoids Fonteintjesberg Azonal Restioid Fynbos (in part)
 - 4.3 Usually >20% shrub cover Jonaskop Mesic Restioid Fynbos
5. No cover above 0,5 m, >60% total cover Trident Azonal Restioid Fynbos
6. <50% restioids or <50% total cover or elytropappoids or >1% succulents or >10% above 0,5 m
 - 6.1 Leafy sedges; or >20% restioids >1 m: or >30% cover >1 m, stoeboids present, >5% Ericaceae Hex Dry Restioid Fynbos
 - 6.2 Not as above Wolfberg Azonal Restioid Fynbos
7. Not as above. Fonteintjesberg Azonal Restioid Fynbos

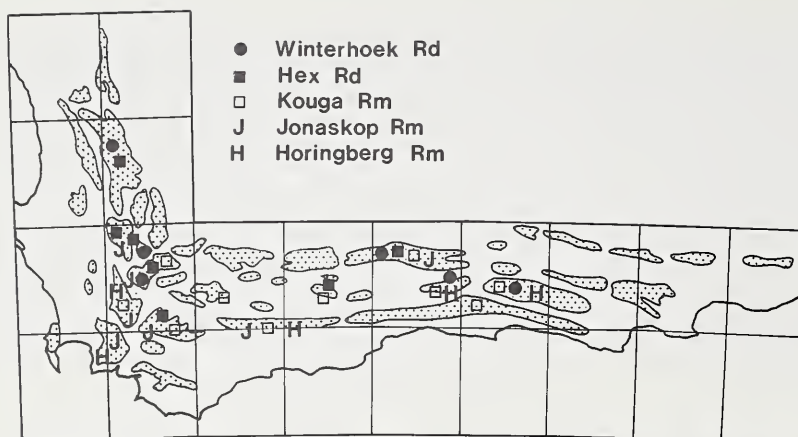


FIG. 32.—Distribution of Dry (Rd) and Mesic (Rm) Restioid Fynbos.



FIG. 33.—Winterhoek Dry Restioid Fynbos. In this example of Winterhoek, *Protea laurifolia* is the occasional emergent proteoid and the predominantly restioid stratum is dominated by *Hypodiscus argenteus* and *Thamnochortus dichotomus*. Hex River Mountains, north slopes, c. 700 m.

Winterhoek Dry Restioid Fynbos (Type Rd1)

Stratification: 32 (see Fig. 4, p.8).

Formation: Low, mid-dense, restioid, leptophyllous shrubland or mid-high, mid-dense restioland with a sparse to very sparse, proteoid overstorey (Fig. 33).

Differentiating features: Of the two types of Dry Restioid Fynbos, Winterhoek possesses an overstorey of proteoids (in particular of seed-regenerating species), whereas Hex Rd lacks this overstorey. Of all the types of Dry and Mesic Restioid Fynbos, Winterhoek tends to have the tallest vegetation (owing to the presence of tall proteoids). Ericaceae generally have a higher cover in Winterhoek than in Hex.

Floristics: Apart from the species mentioned as common to both types of Dry Restioid Fynbos, other dominants include *Hypodiscus argenteus*, *Salaxis axillaris*, *Diosma apetala* and *Restio patens*. Ericaceae are much more

common as dominants in Winterhoek than in Hex Rd. Emergents include *Protea laurifolia*, *P. repens*, *P. neriifolia*, *P. laurifolia*, *P. punctata* and *P. glabra*.

Distribution: NW, C & SI (Fig. 32).

Environment: Altitudes vary between 700 m and 1 600 m, and mean annual rainfall ranges from 400 mm to 1 800 mm.

Hex Dry Restioid Fynbos (Type Rd2)

Stratification: 32, 34.

Formation: Low, mid-dense, restioid, leptophyllous shrubland or mid-high, mid-dense restioland (Fig. 34).

Differentiating features: Differentiating features of Hex, but with generally low constancy, are aphyllous grasses, stoeboids, >20% tall restioids, >5% orthophyllous shrubs, pubescent and annual forbs and net-veined geophytes.

Grass cover is higher in Hex (often > 10%) than in Winterhoek. The only other types of Restioid Fynbos with high grass cover are Horingberg Rm and types in Azonal Restioid Fynbos.

Floristics: Apart from the dominants mentioned as common to both types of Dry Restioid Fynbos, other dominants include *Cannomois scirpoides*, *R. ocreatus*, *Stoebe plumosa*, *Felicia filifolia*, *Pentastichis eriostoma* and *Pentameris dregeana*. Unlike Winterhoek Rd, Hex has fewer Ericaceae as dominants and more Poaceae.

Distribution: C & SI (Fig. 32).

Environment: Hex often occurs at higher altitudes and under higher rainfall than Winterhoek Rd (e.g. medians of 1 500 m and 1 200 mm p.a. in Hex, and of 1 300 m and 900 mm p.a. in Winterhoek).

Mesic Restioid Fynbos (Subseries Rm)

Differentiating features: Mesic Restioid Fynbos is chiefly differentiated from Dry Restioid Fynbos by tending to have a higher total cover (> 80%) and a higher cover of graminoids (> 70%), sedges (> 20%) and narrow-leafy sedges (> 10%). With greater constancy in Mesic Restioid Fynbos are wide-leafy sedges, meso-macrophyllous evergreen geophytes, lobed-leaved non-proteoid shrubs and, to a lesser extent, Penaeaceae. Cover of Ericaceae > 5% occurs more often in Mesic Restioid Fynbos.

Floristics: *Elegia parviflora* is common as a dominant in Mesic Restioid Fynbos but it is also a feature of Dry Restioid Fynbos. Relatively common dominants that are more or less restricted to Mesic Restioid Fynbos are *Hypodiscus synchroolepis*, *H. aristatus*, *Cannomois virgata*, *Staberoha aemula*, *Restio filiformis*, *R. triticeus*, *Stoebe spiralis*, *Phaenocoma proliferum*, *Corymbium* spp., *Erica hispidula*, *E. vestita*, *E. altivivens*, *Protea magnifica*,

Tetraria flexuosa, *T. ustulata*, *T. fourcadei*, *T. bromoides* and *T. aristata*. Over 15% of the dominants recorded in Mesic Restioid Fynbos were sedges (under 5% in Dry Restioid Fynbos).

Distribution: SW & SI (Fig. 32).

Environment: Unlike Dry Restioid Fynbos, Mesic Restioid Fynbos is not found in the dry and hot north-west; it is more a feature of the coastal south-western mountains.

Kouga Mesic Restioid Fynbos (Type Rm1)

Stratification: 32, 34.

Formation: Low, mid-dense to closed, restioid, leptophyllous shrubland or mid-high, mid-dense to closed restioid with a sparse to very sparse, proteoid overstorey.

Differentiating features: Winterhoek Rd and Kouga share a number of features because they both possess seed-regenerating proteoids in the overstorey (features such as microphyllous proteoids and cover in the 1,5–5 m height classes). Deciduous geophytes are found in Winterhoek Rd, Hex Rd and Kouga but not in the other types of zonal Restioid Fynbos.

Floristics: Apart from the dominants mentioned under Mesic Restioid Fynbos, other common dominants are *Elegia vaginulata*, *Hypolaena purpurea*, *Hypodiscus striatus* and *Cannomois dregei*. The emergents include *Protea repens*, *P. punctata*, *P. neriifolia*, *P. lorifolia* and *Leucadendron eucalyptifolium*. Unlike Winterhoek Rd, Kouga never has *Protea laurifolia* or *P. glabra* as a dominant.

Distribution: C, SW & SI (Fig. 32).



FIG. 34.—Hex Dry Restioid Fynbos. This chiefly graminoid community is dominated by *Restio ocreatus* and *Cannomois scirpoides*. Voorstehoek, Cedarberg, c. 1 600 m.



FIG. 35.—Jonaskop Mesic Restioid Fynbos. In this example, the dense restioid community is dominated by *Chondropetalum andreaeanum*. Proteoids may be present in Jonaskop (*P. magnifica* in this example) but they are not tall emergents as in Kouga Rm. Jonaskop, Riviersonderend-berge, c. 1 500 m.



FIG. 36.—Horingberg Mesic Restioid Fynbos. In this example, the pronounced grassiness of Horingberg can be seen (mostly *Pentameris macrocalycina*). Kouga, c. 1 600 m.

Environment: Kouga occupies a range of climates and altitudes (e.g. mean annual rainfall ranging from 600 mm to 2 000 mm, and 1 100 m to 1 500 m elevation) and the median soil depth is 0,3 m. Soils are almost always of the Mispah Form, with occasional soils of Glenrosa Form.

Synonymy: The synonyms for Kouga mostly come from Bond (1981). His *Elegia galpinii*–*Metalasia pulcherrima* Community from the Outeniqua Mountains would be classed as Kouga. In this community *Elegia galpinii* is the dominant in the restioid understorey, and the emergent proteoids include *Protea repens*, *P. lorifolia* and *Leucadendron ericifolium*. Bond's *Cliffortia tuberculata*–*Thorasperma galpinii* Community is, in part, Kouga Mesic Restioid Fynbos and his *Protea repens*–*P. lorifolia*–*Hypodiscus striatus* Community is also Kouga, except

that the xeric facies of this community would probably be better placed in Winterhoek Rd. Variation N1a of Taylor & Van der Meulen's (1981) Community N1 would be included in Kouga and Winterhoek.

Jonaskop Mesic Restioid Fynbos (Type Rm2)

Stratification: 32, occasionally 21.

Formation: Low, closed, restioid, leptophyllous shrubland or mid-high, closed restioland (Fig. 35).

Differentiating features: Jonaskop does not possess good differential features. Like Kouga Rm, it has high cover values for total cover, graminoids and sedges (i.e. the characters shared by Mesic Restioid Fynbos) and,

like Hex Rd, it lacks an overstorey of seed-regenerating proteoids. It shares a number of features with Kouga, but not with Horingberg Rm, amongst which are restioid-like ferns, Bruniaceae and low mesophyllous proteoids (and, in general, low proteoids) e.g. *Protea magnifica*.

Floristics: Common dominants in Jonaskop, apart from those mentioned in the introduction to Mesic Restioid Fynbos, include *Restio egregius*, *Elegia juncea*, *Hypolaena diffusa*, *R. bifidus*, *Chondropetalum deustum* and *C. paniculatum*.

Distribution: C, SW & SI (Fig. 32).

Environment: Relative to Kouga, Jonaskop Rm occupies slightly shallower soils (median depth of 0,2 m), and tends to be found under higher rainfall (median annual of 1 600 mm, cf. 1 000 mm in Kouga). Snow is probably an important factor in determining the distribution of Jonaskop. Because Jonaskop is mostly found at high altitudes, snow will cover the vegetation for considerable periods during winter. Unlike Kouga Rm, soils are predominantly of the Cartref Form, which reflects the higher rainfall. However, soils of Mispah Form are also relatively common.

Synonymy: Most of Kruger's (1979a) herbland class would be classed in Kouga. However, his class is much wider in concept, including *Hypolaena crinalis* communities (best placed in Sneekop Ra) and other shaleband restioid communities (better placed in Langberg Ra or Boesmansbos Ra).

Horingberg Mesic Restioid Fynbos (Type Rm3)

Stratification: 21, 32, occasionally 12.

Formation: Dwarf to mid-high, closed, grassy restioidland (Fig. 36).

Differentiating features: On the basis of a high grass cover (>20%), Horingberg is clearly differentiated from other types of Restioid Fynbos. Fine aphyllous sedges (>10%) are also common and graminoid cover is characteristically over 90%. Horingberg lacks a number of features that are found in other types of Restioid Fynbos, including pubescent shrubs, broad-leptophyllous shrubs, coarse aphyllous sedges, succulents and mat proteoids.

Floristics: The dominants in Horingberg are mostly different from those in the other types of Mesic Restioid Fynbos. In common are *Thamnochortus argenteus*, *Hypodiscus aristatus*, *Restio sieberi*, *Erica hispida*, *E. altivivens*, *Pentameris macrocalycina* and various *Tetraria* spp. Unlike the other types, the number of grass dominants is high (23% of the dominants; less than 5% in the other types) and the numbers of sedge and Ericaceae dominants are higher (up to 25% in each case). Apart from the dominants mentioned above, others include *Chondropetalum ebracteatum*, *C. esterhuyseniae*, *Restio* sp., *Hypodiscus albo-aristatus*, *Erica melanthera* and *Tetraria exilis*.

Distribution: C, SW & SI (Fig. 32).

Environment: Of all the types of Mesic Restioid Fynbos, Horingberg occurs at the highest altitudes (when compared with other types on the same transect). It usually occurs on exposed ridges or peaks, but is not sufficiently low in stature to be classed as Trident Azonal Restioid Fynbos. Soils are of Cartref and Mispah Forms.

Synonymy: The more grassy facies of Bond's (1981) *Cliffortia tuberculata*–*Thoracosperma galpinii* Community from the Swartberg approaches Horingberg.

Azonal Restioid Fynbos (Subseries Ra) (Table 17)

Differentiating features: Not all the types of Azonal Restioid Fynbos are clearly differentiated from certain types in Zonal Restioid Fynbos, but in general Azonal Restioid Fynbos has one or more of the following differentiating features: a high total cover (>90%), >90% restioid cover, >20% grass cover, only 0–5% Ericaceae, >20% aphyllous sedges, only 0–10% shrubs, and >90% relative cover of graminoids. Relative to Zonal Restioid Fynbos, there is a lower constancy of leaf-spinescent and aphyllous shrubs. The most important characteristic of Azonal Restioid Fynbos is the extremely high graminoid cover relative to shrubs.

Floristics: Most of the dominants of Azonal Restioid Fynbos are not restricted to this subseries, also being found in other subseries of Restioid Fynbos, the exception being the dominants of Sneekop Ra and Crystal Ra, which are restricted to these types and to other phreatic sites. Only a few dominants are found in more than three of the types. These include *Restio sieberi*, *R. laniger* and *R. curviramis*.

Distribution: Azonal Restioid Fynbos is typically a western subseries. It is characteristic of the North-Western, Central and South-Western Mountain Regions (Fig. 37).

Environment: Azonal Restioid Fynbos occurs under conditions where shrubs are unable to achieve dominance and in some cases, where shrubs are completely excluded. Soils are generally deep and rock-free (averages of 0,6 m depth and 25% cover respectively) and the sites where Azonal Restioid Fynbos is found are as follows: deep, coarse-textured sand plateaux; plateaux or alluvial terraces where there is excessive waterlogging; exposed high-altitude peaks; shalebands. Azonal Restioid Fynbos is never extensive: it always occupies localized sites.

Synonymy: One of Kruger's (1979a) major groups of mountain fynbos, the vegetation of the plateaux and depressions, corresponds to two of my types of Azonal Restioid Fynbos, Wolfberg and Fonteintjesberg. Kruger's restiad herblands (in another of his major groups viz phreatic site vegetation) corresponds to Sneekop Azonal Restioid Fynbos. Azonal Restioid Fynbos is described under Hygrophilous Fynbos and under the ericoid-restioid zone in Taylor (1978).

Wolfberg Azonal Restioid Fynbos (Type Ra1)

Stratification: 12, 21, 32.

Formation: Mid-high, open to mid-dense restioid usually with very sparse to sparse, low shrubs (Fig. 38).

Differentiating features: Wolfberg is differentiated from other types of Azonal Restioid Fynbos by usually having a low total cover (a character also of Trident Ra) and often having a high cover of aphyllous sedges (>20%). It shares a number of characters with Langberg Ra but lacks the high total cover and the usually high grass cover of Langberg. Wolfberg is the only type of Azonal Restioid Fynbos which possesses elytopappoids. Wolfberg grades into Hex Rd. They share characters such as elytopappoids, net-veined and microphyllous geophytes, annual forbs and aphyllous grasses. However, aphyllous sedges above 20% are never found in Hex. Unlike Wolfberg, Hex is generally taller (vegetation never being lower than 0.5 m) and it never has such a high relative cover of restioids or graminoids. Wolfberg may have a total cover below 50%, but if so, restioids (or other graminoids) contribute a major proportion of the cover and there is

bare soil in the spaces between the plants. If Hex has a low total cover then the spaces are filled by rocks (with less than 5% bare soil).

Floristics: Dominants include *Restio laniger*, *R. sieberi*, *R. curviramis*, *R. strobilifera*, *Cannomois scirpoides*, *Willdenowia sulcata*, *Staberoha* sp., *Tetraria cuspidata*, *T. fasciata*, *Elytropappus rhinocerotis*, *Stoebe spiralis*, *Pentaschistis eriostoma*, *Leucadendron teretifolium* and *Elegia parviflora*.

Distribution: NW, C & I (Fig. 37).

Environment: Wolfberg is characteristic of flat sand plateaux in the north and interior. Annual rainfall usually averages from 500 mm to 1 200 mm. Soils are generally deep (>0.4 m), and rock cover is only occasionally very high (e.g. 80%). Soils are mostly of the dry series of Fernwood Form, but also found are soils of Clovelly, Hutton, Glenrosa and Swartland Forms.

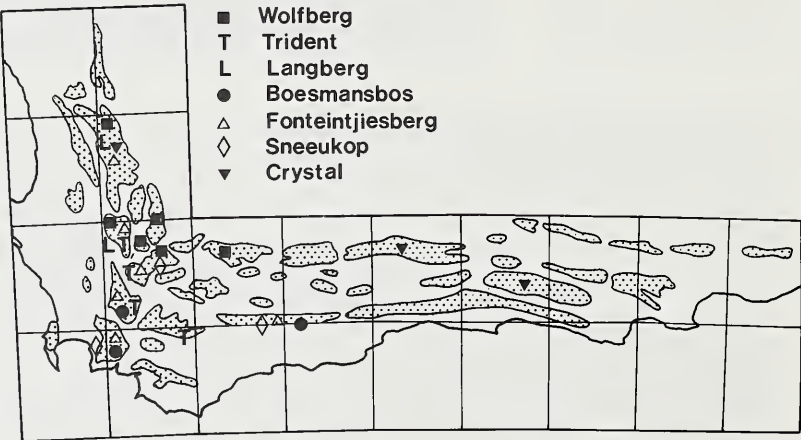


FIG. 37.—Distribution of Azonal Restioid Fynbos.



FIG. 38.—Wolfberg Azonal Restioid Fynbos. *Cannomois scirpoides* and *Restio virgeus* are the dominants. Wolfberg Arch, Cedarberg, c. 1 600 m.

FIG. 39.—Trident Azonal Restioid Fynbos. This example, from above 1800 m in the Hex River Mountains, is dominated by *Restio curviramis* and *Restio brachiatus*.



Trident Azonal Restioid Fynbos (Type Ra2)

Stratification: 12.

Formation: Dwarf to occasionally mid-high, open restioid land (Fig. 39).

Differentiating features: The low stature combined with the low total cover (20–60%) distinguishes Trident from all other types of Restioid Fynbos. Trident is similar in height and closure to Tafelberg Ericaceous Fynbos, but Trident lacks the high cover of Ericaceae. Aphyllous grasses and deciduous geophytes are shared with Wolfberg Ra and Langberg Ra. Grass cover is occasionally up to 20%.

Floristics: Dominants include a number which are also found in Wolfberg Ra, e.g. *Restio laniger*, *R. sieberi*, *R. curviramis*, *R. virgeus* and *Elegia parviflora*. Other dominants are *Stoebe plumosa*, *Metalasia* sp., *Restio ocreatus* and *R. nodosus*.

Distribution: NW, C & SW (Fig. 37).

Environment: The important habitat feature of Trident is its restriction to peak tops. It mostly occurs above 1700 m and has an average rainfall between 1200 and 3600 mm p.a. Unlike most other types of Azonal Restioid Fynbos, Trident is found on very shallow soils mostly with >70% rock cover (Mispah, Cartref and Glenrosa Forms).

Synonymy: At least part of Bond's (1981) *Erica petraea*–*E. nervata* Community from the high altitudes in the Swartberg probably relates to Trident. Taylor (1978) and Marloth (1902) have discussed the vegetation of the high peaks, much of which would be classified as Trident. They note that because of the absence of permanent snow, an alpine flora well distinct from that of the mountain slopes is lacking.

Langberg Azonal Restioid Fynbos (Type Ra3)

Stratification: 21, 32.

Formation: Mid-high, closed restioid land with grasses (Fig. 40).

Differentiating features: There are no features which are exclusive to Langberg, but the combination of mat proteoids and >10% grass differentiates Langberg from other types of Azonal Restioid Fynbos. Mat proteoids are to a lesser extent also characteristic of Wolfberg Ra, and other features that are shared with Wolfberg (and Trident Ra) are aphyllous grasses, deciduous geophytes and succulents. Spinescent shrubs are found in Wolfberg, Trident and Crystal Ra. Unlike Trident and Wolfberg, Langberg tends to have a higher total cover (>80%, a feature of all the other types of Azonal Restioid Fynbos) and a higher graminoid cover. In having a high grass cover, Langberg is similar to Horingberg Rm, but there are few other similarities. Unlike Horingberg, it generally has aphyllous grasses, a lower Ericaceae cover, mat proteoids, and a lower cover of leafy sedges.

Floristics: Especially common as a dominant is *Restio sieberi*. Other dominants are *R. laniger*, *R. filiformis*, *Pentameris macrocalycina* and *Aristida junciformis*.

Distribution: NW, C & SW (Fig. 37).

Environment: Langberg and Boesmansbos Ra are found on shalebands under similar annual rainfall (averaging from 1200 mm to 1600 mm) although Boesmansbos may be found under much higher rainfall. Boesmansbos is more a feature of the cool coastal mountains, whereas Langberg is common in the dry and hot north-west. Soils appear to be shallower in Boesmansbos and are mostly of the Glenrosa Form in both Langberg and Boesmansbos. Other common soils are of the Hutton,



FIG. 40.—Langberg Azonal Restioid Fynbos on a shale-band in the Cedarberg. *Restio sieberi* and *Pentameris macrocalycina* are the dominants. Langberg, c. 1 600 m.

Swartland, Oakleaf and Longlands Forms. Slopes in Langberg, Boesmansbos and in Trident may be relatively steep (6° to 37°). This is in contrast to most other types of Azonal Restioid Fynbos which are characteristic of terraces and plateaux.

Boesmansbos Azonal Restioid Fynbos (Type Ra4)

Stratification: 21, 32, occasionally 62.

Formation: Mid-high, closed herbland occasionally with tall shrubs (cupressoids and/or proteoids). The herbs are restioids, grasses and sedges.

Differentiating features: Like Langberg, this type has a high cover of grasses. However, Boesmansbos has a number of good differentiating characters, including >10% Ericaceae or ericoid Rosaceae, >20% leafy sedges and one or more of the following: wide-leafy sedges, >1.5 m proteoids, yellow-stemmed aphyllous shrubs, cupressoids, bobartioid geophytes and >10% meso-macrophyllous evergreen geophytes. Langberg and Boesmansbos are also linked by a high constancy of evergreen geophytes. Linking Wolfberg, Langberg and Boesmansbos, and generally absent from other types, are >10% aphyllous sedges (also absent from Langberg), ericoid Asteraceae, mesophyllous non-mat proteoids, >20% leptophylls, low non-mat proteoids and pubescent forbs. Of all the types of Azonal Restioid Fynbos, it is chiefly Boesmansbos and Wolfberg which lack stoeboids. Boesmansbos shares a number of features with Horingberg Rm, including high grass cover and similar amounts of Ericaceae and leafy sedges. However, Boesmansbos can be distinguished from Horingberg by the presence in the former Type of one or more of the following: wide-leafy sedges (>5%), tall proteoids, cupressoids, low proteoids, yellow-stemmed aphyllous shrubs, pubescent shrubs and coarse aphyllous sedges.

Floristics: *Danthonia lanata* is a common dominant. Others include *Hypodiscus albo-aristatus*, *Chondropletalum ebracteatum*, *Tetraria* spp., *Erica hispidula* and *Ehrharta dura*. Emergents are often present (*Protea aurea* and *Widdringtonia nodiflora*).

Distribution: SW & C (Fig. 37).

Environment: See Langberg Ra.

Fonteintjiesberg Azonal Restioid Fynbos (Type Ra5)

Stratification: 12, 21.

Formation: Dwarf to mid-high, closed restioidland (Fig. 41).

Differentiating features: Fonteintjiesberg does not have good diagnostic characters. It is extremely short restioidland, usually without cover above 0.5 m. Total cover is usually high (mostly over 90%) and grass cover is usually low but can be up to 40%. If grass cover is high then the grasses are dwarf grasses (shorter than 0.25 m or even 0.1 m). In physiognomy, Fonteintjiesberg approaches Trident but does not ever combine a very low stature with a very low total cover. Fonteintjiesberg shares features, lacking in Sneekop and Crystal, with the previous types, including the following: grasses below 0.1 m, coarse aphyllous sedges, lobed-leaved non-proteoid shrubs, geophytes, woody plants below 0.25 m and fleshy-leaved shrubs.

Floristics: Dominants include *Restio sieberi*, *R. laniger*, *R. curviramis*, *Staberoha cernua*, *R. pygmaeus*, *Elegia spathacea* and *Tetraria* spp. In most cases there is strong single-species dominance.

Distribution: NW, C & SW (Fig. 37).

Environment: Fonteintjiesberg is found on sand plateaux and in depressions. It is distinguished from Wolfberg by being found under more mesic conditions (e.g. mean annual rainfall may be up to 3 000 mm). Soil depths

vary from 0,2 to over 1,0 m and soils are mostly wet or dry series of Fernwood Form (occasionally Cartref Form).

Synonymy: Adamson (1927) describes many restioid communities from Table Mountain and most of these would be classed as Fonteintjesberg (e.g. especially his communities on horizontal sandstones on the plateaux). Other studies from Table Mountain provide descriptions of Fonteintjesberg, e.g. subcommunity E1 on the Back Table (Glyphis *et al.*, 1978) and various variations of the *Watsonia-Penaea* subcommunity on the Front Table (Laidler *et al.*, 1978). Much of Taylor's (1978) plateau communities fall into Fonteintjesberg but the drier facies would be placed in Wolfberg.

Sneeukop Azonal Restioid Fynbos (Type Ra6)

Stratification: 32 to 43.

Formation: Mid-high to occasionally tall, closed restioid land (Fig. 42).

Differentiating features: Sneeukop is easily distinguished from other types of Azonal Restioid Fynbos by the peculiar, sprawling restioid growth-form. Hummock restioids are also characteristic. Sneeukop may be exclusively restioid.

Floristics: *Hypolaena crinalis*, *Elegia intermedia*, *Epischoenus* sp., *Chondropetalum mucronatum*, *Hypolaena diffusa*, *Anthochortus ecklonii*, *Chrysithrix capensis*, *Restio miser* and *R. subtilis*. There is strong single-species dominance.

Distribution: C & SW (Fig. 37).

Environment: Sneeukop occupies extremely waterlogged sites on the coastal mountains. The soils are deep and organic (Champagne Form). Sneeukop may occur on flat or steep areas, and mean annual rainfall ranges from 1 200 mm to 4 200 mm. Summer mists are often important in supplying moisture, but Sneeukop is, in addition, usually associated with seepage and drainage areas.

Synonymy: Descriptions and synonyms for Sneeukop are available from a number of sources — Taylor (1978): 'slope-type' restioid marsh; Boucher (1978): *Chondropetalum-Restio* Marsh Community; Glyphis *et al.* (1978): *Erica mollis* Fynbos Community; Laidler *et al.* (1978): *Restio-Hypolaena* subcommunity; Kruger (1979a). Restiad herblands (in part).

Crystal Azonal Restioid Fynbos (Type Ra7)

Stratification: 43 to 65.

Formation: Tall to very tall, closed restioid land.

Differentiating features: Crystal stands out amongst the types of Azonal Restioid Fynbos as it is the only type having a large amount of cover above 1,5 m. This is due to the high cover of plumose restioids. Tall shrubs (e.g. nanophyllous shrubs) are also differential but with low cover. Other occasional features include >10% cover of non-pubescent forbs, ferns, microphyllous non-proteoid shrubs and creeping forbs. Restioid cover >60% and total cover >90% are features of Fonteintjesberg, Sneeukop and Crystal. Crystal tends to lack sedges, unlike all other types of Azonal Restioid Fynbos.

Floristics: *Cannomois virgata*, *Elegia capensis*, *Leptocarpus paniculatus*, *Danthonia stricta*, *Cliffortia strobilifera*, *Stoebe plumosa* and *Todea barbara*. There is strong single-species dominance.

Distribution: NW & SI (Fig. 37).

Environment: Crystal is found on deep soils of Fernwood Form near drainage lines and, unlike Sneeukop, is more a feature of interior mountains. Waterlogging is not as severe in Crystal as it is in Sneeukop.

Discussion

Relationships to other communities

Dry Restioid Fynbos is very close to Oligotrophic Asteraceous Fynbos, with the latter being found under

FIG. 41.—Fonteintjesberg Azonal Restioid Fynbos. This example from the top of Table Mountain is dominated by *Chondropetalum ebracteatum* and *Thamnochortus nutans*, and is relatively peculiar in that total cover is low. This low cover occurs, despite the high rainfall, because of the extremely shallow soils. The soils alternate between being waterlogged and being extremely droughty. Approximately 1 000 m elevation.





FIG. 42.—Sneeukop Azonal Restioid Fynbos. This example of Sneeukop, in the foreground, shows the sprawling restioid, *Hypolaena crinalis*. The taller coarse restioid is *Chondropetalum mucronatum*. Table Mountain, c. 700 m.

more xeric conditions (e.g. at lower altitudes or, if it occurs at the higher altitudes, then it is restricted to steep northerly aspects). Some stands of vegetation have more non-ericaceous shrub cover than restioids, but the restioids are tall (e.g. 1,0 m) and the shrubs are low (0,25–0,5 m). These stands have been placed in Restioid Fynbos if restioid cover is greater than 20–30%, and they mostly fall into Dry Restioid Fynbos.

At the mesic extreme of Zonal Restioid Fynbos, Jonaskop and Horingberg are close to Mesic Ericaceous Fynbos. Similarities include a high cover of sedges, a lack of overstorey proteoids such as *Protea repens*, *P. lorifolia* and *P. neriifolia*, and Jonaskop and Horingberg often have high cover of Ericaceae (but never as high as in Ericaceous Fynbos). The relatively high cover of grass in Horingberg is also a feature of much Ericaceous Fynbos.

Azonal Restioid Fynbos is sometimes close to Grassy Fynbos and even to Grassland (particularly to Waterkloof S7 and Engelseberg Gm). For instance, Langberg and especially Boesmansbos have a high grass cover and a classification based purely on grass cover would place some of Boesmansbos in Grassy Fynbos. The alpine restioid community, Trident, is physiognomically very similar to the ericaceous alpine community, Tafelberg Em. The environmental conditions separating these two types are the same that separate the series to which the types belong, with Trident being found on the crests and on the northerly aspects just below the crests and with Tafelberg being more restricted to the mesic, southerly aspects below the crests (often where soils are deeper).

Shaleband vegetation

Previous generalizations about the vegetation on the T.M. shaleband have stressed the predominantly restioid nature of the vegetation (e.g. Kruger, 1979a). In general, this is true, but the complexity of the shaleband vegetation should be recognized. Environmental conditions change markedly as the amount of quartzitic colluvium mixed with shale-derived material varies and as moisture

conditions vary. Localized areas on shalebands are often more mesic than the surrounding quartzites, probably because moisture is forced to the surface by impervious bedrock. In response to the steep environmental gradients, the vegetation shows complex patterns. Where there is much colluvial material the vegetation may be Dry Restioid Fynbos, but the most common type of shaleband vegetation of the interior mountains is Langberg Azonal Restioid Fynbos. More common on the coastal mountains is Boesmansbos Ra, but this is a very variable community, sometimes being a herbland and other times having a cupressoid or proteoid emergent layer. In the Baviaanskloof, shalebands often have Hankey Grassland, and in the Kammanassie shalebands have Grahamstown Grassy Fynbos, Mannetjiesberg Grassy Fynbos and various types of Proteoid Fynbos. Other commonly found types on shalebands are Crystal Ra, Sneeukop Ra, Wet Proteoid Fynbos and Mesic Ericaceous Fynbos. Where the shaleband descends to low altitudes in some areas in the Cedarberg, it supports Mesotrophic Asteraceous Fynbos and even Renoster Shrubland, whereas the surrounding quartzites have Restioid Fynbos or Oligotrophic Asteraceous Fynbos.

Shalebands are more characteristic of the western area and this is perhaps one reason why Azonal Restioid Fynbos is chiefly a feature of the west. However, it is also in the west that the shaleband environment, apart from the seepage area of the shaleband, is more extreme than that in the east. In the winter, the high rainfall results in relatively waterlogged conditions, whereas in summer the clay-rich soils are extremely droughty. The same moisture fluctuation occurs on the surrounding quartzites but is not as extreme because the soils are sandy and better drained. The links that Langberg Ra and Boesmansbos Ra have with other types of Azonal Restioid Fynbos such as Wolfberg and Fonteintjiesberg can therefore be seen: waterlogged conditions alternate with droughty conditions with the resulting exclusion of most shrubs. The similarity between Wolfberg Ra and Hex Dry Restioid Fynbos can also be understood in this light; waterlogging is least severe in Wolfberg and therefore shrubs are often present.

Ericaceous Fynbos (Series E)

The differentiation of Ericaceous Fynbos into types of Mesic and Wet Ericaceous Fynbos is set out in Table 18 and Key 9. The descriptions of types are arranged in order according to Table 18.

Mesic Ericaceous Fynbos (Subseries Em)

Differentiating features. The major diagnostic features of Mesic Ericaceous Fynbos are a high relative cover of Ericaceae (>30%), woody cover below 0,25 m, graminoid cover below 0,1 m and non-ericaceous ericoid shrubs. Lower-constancy differentiating characters are deciduous geophytes, grasses below 0,1 m and lobed-leaved non-proteoid shrubs.

Floristics: There are very few dominants that are common to more than two of the three types of Mesic Ericaceous Fynbos. The few exceptions are *Elegia* spp. (*E. vaginulata*, *E. racemosa*), *Restio sejunctus*, *Pentstemonis* sp., *Tetraria fasciata*, *T. cuspidata*, *Leptocarpus membranaceus*, *Chondropetalum ebracteatum* and *Erica hispidula*. *Erica hispidula* is the most common dominant in Nuweberg Em and Landdros Em.

Distribution: Mainly SW & C (Fig. 43).

Environment: In Mesic Ericaceous Fynbos, soils average 0,5 m in depth and 51% rock cover. Mesic Ericaceous Fynbos is especially a feature of the high-altitude south-facing slopes of the coastal mountains, with Zonal Restioid Fynbos being found on the xeric north-facing slopes where soils are shallower. Both subseries of Ericaceous Fynbos occur under high rainfall (average of 1 500 mm p.a.) but Wet Ericaceous Fynbos often occurs at lower altitudes.

Tafelberg Mesic Ericaceous Fynbos (Type Em1)

Stratification: 12, 21 (see Fig. 4, p.8).

Formation: Dwarf to low, sparse to closed, ericaceous shrubland to restioid, ericaceous shrubland (Fig. 44).

Differentiating features: Tafelberg is distinguished from other types of Ericaceous Fynbos by its low stature and high constancy of stoeboid and pubescent-leaved shrubs. By having >30% absolute or relative cover of Ericaceae, Tafelberg is distinguished from Trident Azonal Restioid Fynbos. Trident has less than 10% absolute or relative cover of Ericaceae, but also has stoeboids, pubescent-leaved shrubs and low stature.

Floristics: Dominants include *Elegia* spp., *Erica* spp., *Cliffortia eriocephalina* and *Stoebe plumosa*.

Distribution: Unlike other types of Ericaceous Fynbos, Tafelberg is restricted to interior mountains (NW, C & SI: see Fig. 43).

Environment: The important environmental factors determining the distribution of Tafelberg relate to altitude and exposure. All plots representing Tafelberg were recorded from exposed peaks above 1 700 m. Soils in Tafelberg vary from being shallow (0,1 m) and rocky (95% cover) to being deep (1,0 m) and rock-free (Mis-pah, Cartref and Oakleaf Forms).

Synonymy: Some of Bond's (1981) *Erica petraea*–*E. nervata* Community could probably be placed in Tafelberg.

Nuweberg Mesic Ericaceous Fynbos (Type Em2)

Stratification: 32, 43, occasionally 21, 56.

Formation: Low to occasionally mid-high, closed, ericaceous shrubland.

KEY 9.—Key to the types of Ericaceous Fynbos

- 1. Extremely low stature (mostly below 0,25 m) and stoeboids present Tafelberg Mesic Ericaceous Fynbos
- 2. Very wide leafy sedges present or >5% leaf spinescence or grass >0,5 m or >20% ericoids (Asteraceae) Nuweberg Mesic Ericaceous Fynbos
- 3. >5% grass or >10% cover below 0,25 m or >70% restioids of 0,25–0,5 m
 - 3.1 >10% broad-leptophyllous shrubs or >50% sprawling restioids Ruiterberg Wet Ericaceous Fynbos
 - 3.2 Not as above Landdros Mesic Ericaceous Fynbos
- 4. >20% above 2 m or >50% restioids above 0,5 m or >60% Bruniaceae Keurbos Wet Ericaceous Fynbos

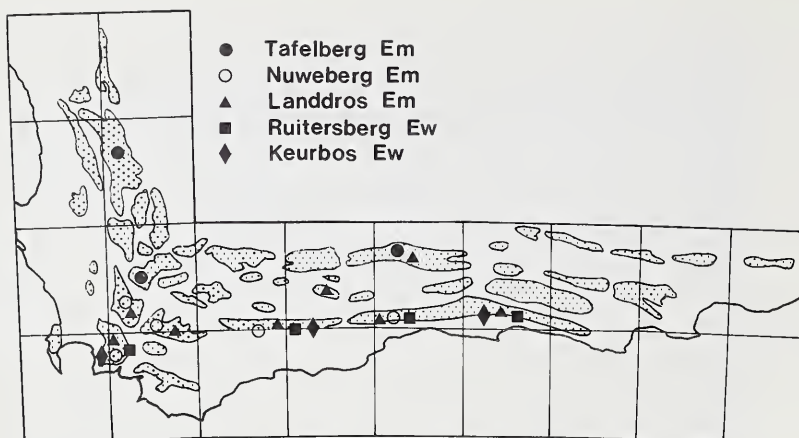


FIG. 43.—Distribution of Mesic (Em) and Wet (Ew) Ericaceous Fynbos.

Differentiating features: Nuweberg has a good set of diagnostic features, including very wide-leafy sedges (*Tetraria thermalis*), leaf-spinescent shrubs, moderately tall grasses (0.5–1 m) and aphyllous grasses. Ericoid-leaved Asteraceae are present in both Tafelberg and Nuweberg. Nuweberg generally lacks or has low constancy of: Bruniaceae; >60% restioids; >5% geophytes; and proteoids.

Floristics: Dominants include *Erica hispidula*, *Restio egregius*, *Blaeria ericoides*, *Erica viridescens*, *Ehrharta dura*, *Tetraria* sp., *T. fasciata*, *Hypolaena diffusa* and *Hypodiscus aristatus*.

Distribution: SW & SC (Fig. 43).

Environment: Nuweberg is found in more xeric positions relative to Landdros Mesic Ericaceous Fynbos. The habitat is more xeric in terms of aspect, rainfall, or soil factors. The soils of Nuweberg tend to be rockier (often

over 80% cover) perhaps shallower (often less than 0.5 m), and mostly of Mispah and Cartref Form. Altitudes are usually below 1000 m, annual rainfall is usually about 1000 mm and aspects are often northerly.

Synonymy: A number of previously described communities could be classed as Nuweberg. Bond's (1981) *Erica viridescens*–*Hypodiscus aristatus* Community includes *Tetraria thermalis* and is dominated by *Erica viridescens*, but some facies of Bond's community would be excluded because proteoid cover exceeds 10% (*Leucadendron uliginosum*). Other descriptions of Nuweberg include the following: Kruger (1974): *Tetraria thermalis*–*Hypodiscus aristatus* Communities; Taylor (1978): *Tetraria thermalis* Bergpalmietveld; McKenzie *et al.* (1977): *Leptocarpus membranaceus*–*Hypodiscus aristatus* Community; Kruger (1979a): low ericoid open-heath or open graminoid-heath; Glyphis *et al.* (1978): subcommunity B and C.

FIG. 44.—Tafelberg Mesic Ericaceous Fynbos. The low stature of this type is clearly shown. Ericaceae are often not conspicuous in Tafelberg. The dominants in this example include *Staberoha aemula*, *Diastella proteoides* and *Erica altivivens*. Fontein-tjiesberg, Hex River Mountains, c. 1800 m.





FIG. 45.—Landdros Mesic Ericaceous Fynbos. In this example, *Erica hispidula* and *Elegia vaginulata* are the dominants with *Protea punctata* as an emergent. Swartberg, c. 1700 m.

Landdros Mesic Ericaceous Fynbos (Type Em3)

Stratification: 32, 21, 34.

Formation: Low, closed, ericaceous shrubland (Fig. 45).

Differentiating features: Landdros does not have clear-cut diagnostic attributes. Low-constancy differentiating features include creeping forbs and microphyllous non-proteoid shrubs. This Type has a much higher constancy of erect forbs than Nuweberg and it also has much higher cover in the 0.25–0.5 m height class, but these features are also shared with Ruitersberg Wet Ericaceous Fynbos. Proteoids (mostly mesophyllous and below 1 m) are more constant in Landdros and Ruitersberg than in Nuweberg. Landdros and Nuweberg share a number of characters that are apparently not found in Trident, e.g. narrow- and wide-leafy sedges, net-veined geophytes, yellow-stemmed aphyllous shrubs and restioid-like ferns. Orthophyllous shrubs are more a feature of Trident and Landdros, than Nuweberg.

Floristics: Dominants include *Elegia racemosa*, *Restio sejunctus*, *R. debilis*, *Leucadendron gandogerii*, *Penaea cneorum*, *Tetraria fasciata*, *T. exilis*, and *Erica* spp.

Distribution: Mostly SW & SC (Fig. 43).

Environment: See the discussion under Nuweberg for differences between these two types. Landdros is usually found above 1100 m elevation and under rainfalls ranging from 900 mm to 4200 mm. Aspect is almost always southerly. Rock cover usually varies from 15–50% and soil depth varies from 0.3–0.9 m. Soils are of the Mispah, Cartref or, occasionally, Oakleaf Forms.

Synonymy: A number of Bond's (1981) communities could be classed as Landdros, including the *Erica arachnoidea*–*Pentameris dregeana* Community from the Outeniqua Mountains and the *Erica petraea*–*E. nervata*

and *Protea punctata*–*Erica melanthera*, *E. andraei* Communities from the Swartberg Mountains. Other descriptions of Landdros can be found as follows: McKenzie *et al.* (1977): *Cliffortia pedunculata*–*Widdringtonia nodiflora* Community; Kruger (1979a): Tall narrow-sclerophyllous heathland, Low narrow-sclerophyllous heathland and graminoid-heathland; Taylor & Van der Meulen (1981): Community S2.

Wet Ericaceous Fynbos (Subseries Ew)

Differentiating features: Differentiating features of Wet Ericaceous Fynbos are sprawling restioids, broad-leaved Ericaceae, >80% restioids and, to a lesser extent, >10% broad leptophylls and pinnate-leaved ferns. Other distinctive features are a high constancy or cover of Penaeaceae, Bruniaceae and cupressoids. Ericoid Asteraceae, spinescent shrubs and aphyllous shrubs are characteristically absent from Wet Ericaceous Fynbos.

Floristics: Unlike Mesic Ericaceous Fynbos, Wet Ericaceous Fynbos has a much more constant set of dominants. Both types of Wet Ericaceous Fynbos share *Restio compressus*, *R. anceps*, *Erica cordata* var. *arachnoidea*, *Penaea cneorum* and *Hypolaena crinalis*.

Distribution: SW & SC (Fig. 43).

Environment: See Mesic Ericaceous Fynbos. Soils are deep and organic (Champagne Form).

Ruitersberg Wet Ericaceous Fynbos (Type Ew1)

Stratification: 21 to 42.

Formation: Low to mid-high, closed, restioid, ericaceous shrubland (Fig. 46).

Differentiating features: Restioid cover >70% in the 0.25–0.5 m height class, and >10% geophytes are the

only diagnostic characters of Ruitersberg Wet Ericaceous Fynbos. It shares a number of features with types of Mesic Ericaceous Fynbos that are not found in Keurbos Ew2, e.g. restioid cover >80% in the 0,25–0,5 m height class and erect forbs (shared with Landdros); >40% Ericaceae and >10% grass (shared with Landdros and Nuweberg); grass below 0,25 m, relative cover of Ericaceae >10% , cover below 0,25 m, aphyllous sedges, and fine aphyllous sedges (shared with all the types of Mesic Ericaceous Fynbos).

Floristics: Apart from the dominants mentioned under the introduction to Wet Ericaceous Fynbos, other dominants include *Anthochortus ecklonii* and *Erica* spp. (e.g. *E. calycina* and *E. stylaris*).

Distribution: SW & SC (Fig. 43).

Environment: Ruitersberg is found on deep rock-free organic soils on southerly aspects at altitudes above 1 300 m. It occurs where substantial summer moisture is contributed by south-east winds. The soils are always wet and I have classed the soils as Champagne although, as Bond (1981) notes, the binomial system is inadequate for these soils as they do not always overlie gleyed material.

Synonymy: The *Simocheilus carneus*–*Restio anceps* Community (Bond, 1981) falls into Ruitersberg.

Keurbos Wet Ericaceous Fynbos (Type Ew2)

Stratification: 65, 56, occasionally 43.

Formation: Mid-high to tall, closed, leptophyllous (non-ericaceous) shrubland with a low, closed, restioid, ericaceous shrub understorey.

Differentiating features: Keurbos has a large number of clear-cut diagnostic attributes. Unlike all other types of Ericaceous Fynbos it is tall. Differentiating features include high cover above 2,0 m, high restioid cover in the 0,5–1,5 m height class, >60% Bruniaceae, >90% leptophyllous shrubs, ericoid-leaved Grubbiaceae and parasitic climbing forbs. Keurbos shares a number of features with Ruitersberg and Landdros including the following: >60% restioids, Bruniaceae, >5% geophytes, proteoids above 1 m, Penaeaceae and cupressoids.

Floristics: Keurbos has a very constant set of dominant species. Apart from those mentioned under Wet Ericaceous Fynbos, dominants include *Erica lanata*, *Berzelia intermedia* and *Grubbia rosmarinifolia*. Occasional proteoid dominants in the tall berzeloid canopy include *Leucadendron uliginosum* and *L. eucalyptifolium*.

Distribution: SC & SW (more common in SC) (Fig. 43).

Environment: Keurbos is usually found on the lower slopes (below 600 m) but it may be found at higher altitudes. Soils are deep and organic. Relative to Ruitersberg Ew (e.g. when found at the same altitude), Keurbos occupies the more mesic, less-exposed sites. Keurbos is particularly common on the lower, relatively flat, southerly aspects of the Tsitsikamma Mountains. Keurbos is not associated with streams; it is more a feature of perennially wet seepages.

Synonymy: The relatively constant floristic attributes in Keurbos have ensured that this community has been described and identified on numerous occasions, e.g. Boucher (1978): *Erica*–*Osmitopsis* Seepage Fynbos and *Chondropetalum*–*Berzelia* Upper Hygric Fynbos; Laidler *et al.* (1978): Variation I of the *Restio*–*Hypolaena* Community; Kruger (1974): *Brunia alopecuroides*–



FIG. 46.—Ruitersberg Wet Ericaceous Fynbos. In this example, the dominants are *Erica* spp., *Elegia juncea*, *Restio* spp. and *Berzelia intermedia*. Boesmansbos, Langeberg, c. 1 500 m.

Restio bifidus Community; Werger *et al.* (1972): *Berzelia lanuginosa*–*Osmitopsis asteriscoides* Community; Kruger (1979a): Narrow-sclerophyllous and mixed closed-scrub and open-scrub; Glyphis *et al.* (1978): sub-community E2.

Discussion

Relationships to other communities

Ericaceous Fynbos usually occupies a distinct environmental situation, viz south aspects of coastal mountains. The south aspects of the lower-altitude mountains of the most interior mountains (e.g. Witteberg Mountains) and the more mesic, south aspects of the eastern mountains also support ericaceous communities, but these communities are not placed in Ericaceous Fynbos. On the interior mountains, conditions are too xeric to support Ericaceous Fynbos, and the communities are placed in Bantamskop Mesotrophic Asteraceous Fynbos. In the east, the understorey is predominantly grassy and therefore these ericaceous communities are placed in Grassy Fynbos (Grahamstown Ge) and many of them

should even be in Afromontane Fynbos. Grahamstown is distinguished from Ericaceous Fynbos by usually being dominated by a single *Erica* species, whereas Ericaceous Fynbos has up to 14 Ericaceae in a 10 m x 5 m plot (Bond, 1981). Other points of difference are as follows: deciduous shrubs are only ever present in Grahamstown; Penaeaceae and Bruniaceae are mostly absent from Grahamstown; more common in Grahamstown are pubescent shrubs, microphyllous geophytes, rosette forbs, and with lower cover are evergreen geophytes, sedges (<5%) and proteoids. Bantamskop is also relatively easily distinguished from Ericaceous Fynbos. It has <40% Ericaceae, <10% sedges, no leafy sedges and slightly lower cover of evergreen geophytes (mostly 0–1%).

Apart from the above links with geographically isolated types from other series, Ericaceous Fynbos also grades into other series on the same transect. On the gradient from southerly aspects to northerly aspects Ericaceous Fynbos is replaced by Mesic Restioid Fynbos. Landdros Mesic Ericaceous Fynbos is replaced by a proteoid ericaceous community (e.g. the *Protea punctata*-dominated Kammanassie Type) on what appears to be less exposed sites.

Proteoid Fynbos (Series P)

Formation: Mid-high to occasionally tall, open to mid-dense, proteoid shrubland with a low, mid-dense, grass-shrub understorey.

TABLE 19.—The major differentiating features of the subseries and types of Proteoid Fynbos. Most of the subseries are differentiated using the dominant canopy species (mostly proteoids — species of *Protea* and *Leucodendron*)

Subseries	Dominant species	Types					
		Grassy Fynbos	Asteraceous Fynbos	Nature of understory	Restioid Fynbos	Ericaceous Fynbos	Understorey not differential
Mesotrophic Proteoid Fynbos	<i>P. repens</i> , <i>P. laurifolia</i> , <i>P. eximia</i> or <i>L. rubrum</i>	Studtis Swartbos Enon	—	—	—	—	—
	<i>P. nerifolia</i> <i>L. eucalyptifolium</i> — <i>P. nerifolia</i>	—	—	—	—	—	—
Dry Proteoid Fynbos	<i>P. laurifolia</i>	—	Wetvrede Gymanshoek	Hawequas Cango	Benetive Thomas	—	—
	<i>P. repens</i> , <i>P. laurifolia</i> , <i>P. eximia</i> or <i>L. rubrum</i>	—	—	—	—	Ararat	—
Mesic Proteoid Fynbos	<i>P. nerifolia</i>	—	Jonkershoek	—	Toverwater	Sipres	—
	<i>L. eucalyptifolium</i> — <i>P. nerifolia</i>	—	—	—	Sanddrift	Robinson	—
	<i>P. punctata</i>	—	Dassieklip	—	Swartberg	Kamanassie	—
	<i>L. uliginosum</i> or <i>L. loeriense</i>	—	—	—	Bloukrans	Loerie	—
Wet Proteoid Fynbos	<i>P. aurea</i> — <i>L. eucalyptifolium</i>	—	—	—	—	—	Outeniqua
	<i>L. eucalyptifolium</i> — <i>P. mundii</i>	—	—	—	—	—	Otterford
	<i>L. eucalyptifolium</i> — <i>Berzelia</i> <i>L. conicum</i>	—	—	—	—	—	Mangold Kouma

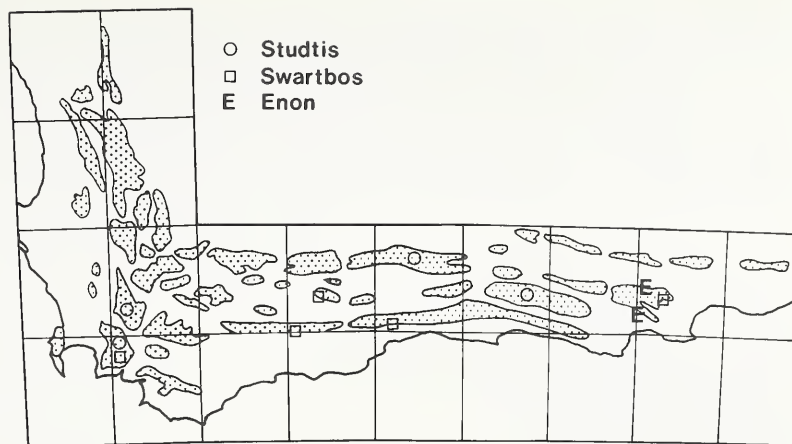


FIG. 47.—Distribution of Mesotrophic Proteoid Fynbos.

Differentiating features: The defining characteristics of Studtis are the proteoids *P. repens*, *P. lorifolia*, *P. eximia* or *Leucadendron rubrum*. A high cover of pubescent-leaved shrubs is a low-constancy structural feature of Studtis.

Floristics: Proteoid dominants as above and *Cliffortia ruscifolia*, *P. nitida*, *Restio gaudichaudianus*, *Rhus angustifolia*, *Cassytha ciliolata*, *Cymbopogon marginatus*, *Merxmüllera stricta*, *M. arundinacea*; *Stoebe plumosa*, *Cliffortia polygonifolia* and *Pentaschistis* sp.

Distribution. C. SW & SI (Fig. 47).

Environment: The three types of Mesotrophic Proteoid Fynbos replace one another along a moisture gradient. Studtis is found in the west where summer drought is most severe and at the other extreme, one finds Enon Pe which is found on steepish south-facing slopes in the east where summer droughts are least severe. The Studtis Type is found on a variety of soils, e.g. of Hutton, Swartland, Oakleaf and Glenrosa Forms.

Swartbos Mesotrophic Proteoid Fynbos (Type Pe2)

Stratification: 34 to 62.

Formation: Mid-high to tall, open to mid-dense, proteoid shrubland with a low, mid-dense, grass-shrub understorey (Fig. 48).

Differentiating features: In Swartbos, *Protea neriifolia* is the dominant proteoid. *P. neriifolia* is also found in Enon Pe, but then it is co-dominant with *Leucadendron eucalyptifolium*. Swartbos has a number of other differentiating features, including coarse aphyllous sedges, >10% evergreen meso-macrophyllous geophytes and Bruniaceae. Swartbos and Studtis Pe share a number of features which are lacking in Enon e.g. climbers (with a low constancy), >30% grass, >40% graminoids, >10% restioids and *P. nitida*. Enon and Swartbos share features which are lacking in Studtis. These include ferns (and especially *Pteridium aquilinum*), microphyllous shrubs, >10% nanophyllous shrubs, Penaeaceae, >5% leaf spinescence and bobartioid geophytes.



FIG. 48.—Swartbos Mesotrophic Proteoid Fynbos. A dense stand of *Protea neriifolia*, with an understorey of predominantly *Cymbopogon marginatus*, *Pentaschistis* sp. and *Lanaria lanata*. Gymanshoekpas, c. 650 m.

TABLE 21.—Differentiated table for the types of Mesotrophic Proteoid Fynbos. See Table 8 for notes on characters and conventions used

	Mesotrophic Proteoid Fynbos														
	Studtis					Swartbos					Enon				
	Plot numbers														
	225	224	265	008	007	184	426	185	484	418	341	412	404	393	
† Pubescent-leaved >*	1	1				0									
Sedge, aphyllous, coarse							1	*		1	0				
Geophyte, evergreen >*						0		1	1	3	0			1	
Geophyte, evergreen, meso-macrophyllous >0								1	1	3					
† Bruniaceae							1		*	1					
# Climber				+		1		0	*		*				
# Total cover, 0,25–0,5 m >3	8	8		5	4	5	6	7	7	9	4				
Grass >2	9	3	3	4			3	4	6	5					
Graminoid >4	9	9		5			7	6	6	9					
Restioid >0				1	1	1	2	1		3					
† Proteoid, <i>Protea nitida</i>				*		1	*	*							
† Ericaceae >2										3		3	4	7	
† Woody plant, non-proteoid >6						7				7	9	9	7	9	
† Leptophyllous >7											8	9		9	
† Nanophyllous, non-proteoid >0						1	2	1		4		1	1	1	
Fern, pinnate-leaved						0	+	0		1		0	*		
† Microphyllous, non-proteoid				*		2	*	*	*	*		*	*		
† Penaeaceae									0	*		*		0	
† Ericoid-leaved (Rhamnaceae, Thymelaeaceae) >0										1		5		1	
† Spinescence, leaves >*						1	1			2			0		
Geophyte, bobartioid							*			0				0	
Fern, <i>Pteridium aquilinum</i>						*		0		1		0			
Fern, restioid-like									+			*			

† = woody plants; * = woody and herbaceous plants; 'no symbol' = herbaceous plants; + = less than 1% cover; * = 1–5%; 0 = 5–10%; 1 = 10–20%; 2 = 20–30%; 3 = 30–40%; 4 = 40–50%; 5 = 50–60%; 6 = 60–70%; 7 = 70–80%; 8 = 80–90%; 9 = greater than 90%.

Floristics: *Protea neriifolia*, *P. repens* (with lower cover than *P. neriifolia*), *Cliffortia ruscifolia*, *Restio gaudichaudianus*, *Aristida junciformis*, *Cymbopogon marginatus*, *Lanaria lanata*, *Pentaschistis* sp., *Erica* sp., *Brunia nodiflora*, *Phylla axillaris*, *Restio triticeus*, *Leucadendron salignum* and *Merxmüllera arundinacea*.

Distribution: SW, SC & SI (Fig. 47).

Environment: See Studtis Pe. Soils are of the Mispah, Glenrosa and Hutton Forms.

Enon Mesotrophic Proteoid Fynbos (Type Pe3)

Stratification: 56, 63.

Formation: Tall to occasionally mid-high, mid-dense, proteoid shrubland with an understorey of low to mid-high, leptophyllous shrubs.

Differentiating features: In Enon, *Leucadendron eucaalyptifolium* is dominant, or it is a co-dominant with *Protea neriifolia*. More than 30% cover of Ericaceae is also differential, as is >70% non-proteoid shrubs (mostly leptophyllous Ericaceae and other ericoids). Grass cover is usually lowest in Enon (<30%)

Floristics: Dominant proteoids as above, other dominants including *Sporobolus centrifugus*, *Thamnos multi-*

florus, *Passerina vulgaris*, *Cymbopogon marginatus*, *Centella virgata*, *Tetraria fasciata* and *Pentaschistis* sp.

Distribution: E (Fig. 47).

Environment: See Studtis Pe. Enon appears to be mainly associated with soils derived from geological formations other than the T.M. quartzites (e.g. Enon conglomerate and Malmesbury shale).

Dry Proteoid Fynbos (Subseries Pd) (Tables 20 & 22)

Differentiating features: The proteoids which define this subseries are *Protea laurifolia*, *P. repens*, *P. lorifolia* and *Leucadendron rubrum*. *Protea eximia* should probably also be included as defining Dry Proteoid Fynbos, but too few stands were taken from *P. eximia* to make a definitive statement about its position. These proteoids, excluding *P. laurifolia*, also occur in Mesotrophic Proteoid Fynbos. Differential features of Dry Proteoid Fynbos include elytropappoids, succulents and >5% ericoid Asteraceae. Features that link this subseries and Mesotrophic Proteoid Fynbos include pubescent shrubs, coarse aphyllous sedges, deciduous shrubs, stoeboids, microphyllous geophytes and >10% leaf spinescence.

Distribution: Most regions, but more common in the C, SW & SI Regions (Fig. 49).

Environment: Rainfall in Dry Proteoid Fynbos averages 950 mm and this is similar to that occurring in the other subseries. The droughty nature of Dry Proteoid Fynbos relates to the more westerly distribution of this subseries relative to the other subseries (i.e. where summer droughts are more extreme). Dry Proteoid Fynbos also has a tendency to be found on more northerly aspects. Soil depth and rock cover average 0,6 m and 50% respectively.

Weltevrede Dry Proteoid Fynbos (Type Pd1)

Stratification: 32 to 56.

Formation: Low to mid-high, open to mid-dense, leptophyllous shrubland, with a sparse, mid-high to tall, proteoid overstorey (Fig. 50).

Differentiating features: Weltevrede is differentiated from the other types of Dry Proteoid Fynbos that are also dominated by *P. laurifolia* by having a high cover of

elytropappoids (10–90%). Grass cover is also high (10–40%) and total cover may often be below 70%. Restioid cover is usually below 10%.

Floristics: *Protea laurifolia*, *Elytropappus rhinocerotis*, *Anthospermum aethiopicum*, *Phylica odorata*, *Pentaschistis eriostoma*, *Hypodiscus neesii* and *Pentaschistis colorata*.

Distribution: C & NW (Fig. 49).

Environment: The three types of Dry Proteoid Fynbos dominated by *Protea laurifolia* occur along a moisture gradient with median rainfall of 800 mm in Weltevrede and 1 200 mm in Hawequas Pd and Benetive Pd. Weltevrede Pd has the most fine-textured soils (sandy clay loams). Soils recorded in this type included the Mispah, Glenrosa and Swartland Forms. The high cover of elytropappoids in some stands of Weltevrede is probably related to the effects of overgrazing.

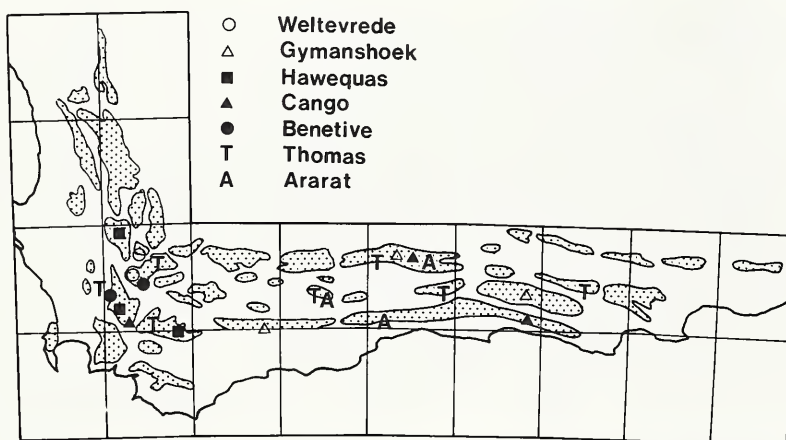


FIG. 49.—Distribution of Dry Proteoid Fynbos.



FIG. 50.—Weltevrede Dry Proteoid Fynbos. *Protea laurifolia* forms the overstorey to *Elytropappus rhinocerotis* and *Pentaschistis colorata*. Gydo Mountains, c. 1 100 m.

Gymanshoek Dry Proteoid Fynbos (Type Pd2)

Stratification: 34 to 63.

Formation: Low to mid-high, open to mid-dense, small-leaved (occasionally large-leaved) shrubland with a sparse to occasionally mid-dense, mid-high to tall, proteoid overstorey.

Differentiating features: The understorey of Gymanshoek is similar to types of Mesotrophic Asteraceous Fynbos. Grass cover is usually above 10% and erect forbs and >10% pubescent shrubs are relatively characteristic. Stoeboids may have >40% cover. Gymanshoek is dominated by *Protea repens*, *P. lorifolia*, *P. eximia* or *Leucadendron rubrum*. Also dominated by these proteoids are Congo Pd, Thomas Pd and Ararat Pd. Ararat is distinguished from Gymanshoek by having a high cover of Ericaceae or Penaeaceae or both (>30% in total), and Ararat and Thomas both have low grass cover (<10%), or if grass cover is high then restioid cover is higher than shrub cover. Cover ratings of restioids (10–50%) and Ericaceae (often >10%) are higher in Gymanshoek than in Weltevrede Pd. Aphyllous sedges are least common in Gymanshoek and Weltevrede, being more characteristic of the other types of Dry Proteoid Fynbos.

Floristics: Proteoids as above, other dominants including *Stoebe plumosa*, *Stoebe cinerea*, *Elytropappus rhinocerotis*, *E. adpressus*, *Montinia caryophyllacea*, *Relhania squarrosa*, *Pentaschistis eriotoma*, *Restio fruticosus*, *Hypodiscus striatus*, *Passerina vulgaris*, *Erica decipiens* and *Lanaria lanata*.

Distribution: SW & SI (Fig. 49).

Environment: The types of Dry Proteoid Fynbos dominated by proteoids other than *P. laurifolia* viz Gymanshoek, Congo, Thomas and Ararat occur along a moisture gradient, with Gymanshoek occurring at the xeric end of the gradient (c. 700 mm rainfall p.a.) and Thomas and Ararat occurring at the mesic end. The *Protea laurifolia* types tend to be more a feature of the drier more western mountains whereas the types in which *P. laurifolia* is not dominant occur more on the southern mountains, or if these other types occur on the same mountain as a *Protea laurifolia* type then they occur at higher altitudes and under higher rainfall. Hutton and Glenrosa are the common soil forms in Gymanshoek and Congo.

Hawequas Dry Proteoid Fynbos (Type Pd3)

Stratification: 43.

Formation: Low to mid-high, mid-dense, leptophyllous shrubland (with open restioid cover) and with a sparse (sometimes open), tall, proteoid overstorey.

Differentiating features: Hawequas and Congo Pd both have an understorey approaching Oligotrophic Asteraceous Fynbos, but Hawequas is differentiated by having *Protea laurifolia* as the dominant proteoid. Other relatively characteristic features of Hawequas are >10% stem spinescence, >10% nanophyllous shrubs, >10% deciduous shrubs and tall (>1.5 m) microphyllous and nanophyllous

shrubs. Total cover can occasionally be <80%, a feature of only Weltevrede, Gymanshoek and Hawequas. Restioids vary from 5–50% and non-proteoid shrubs are usually >60%.

Floristics: *Protea laurifolia*, *Leucospermum calligerum*, *Cliffortia ruscifolia*, *C. crenata*, *Elytropappus glandulosus*, *Agathosma ovata*, *Anthospermum aethiopicum*, *Montinia caryophyllacea*, *Cannomois dregei*, *Stoebe plumosa*, *Erica* sp., *Restio gaudichaudianus* and *Elegia parviflora*.

Distribution: NW, C & SW (Fig. 49).

Environment: See Weltevrede Pd and Gymanshoek Pd. Soils are usually deep, colluvial soils at the base of slopes (Glenrosa and Hutton Forms). Rock cover varies from 50 to 80%.

Congo Dry Proteoid Fynbos (Type Pd4)

Stratification: 43.

Formation: Low to mid-high, open to mid-dense, restioid, leptophyllous shrubland with a sparse to open, mid-high, proteoid overstorey.

Differentiating features: Congo Pd and Thomas Pd with their similar proteoid overstorey are distinguished by their understorey. Non-proteoid shrub cover is always higher than restioid cover in Congo. Bobartioid geophytes appear to have a high constancy in Congo. In Congo and in all the preceding types of Dry Proteoid Fynbos, there is often a high cover in the 1–1.5 m height class because of the high cover of mid-high shrubs that are present and it is in these types that there are often >30% non-ericaceous ericoids, >10% ericoid Rhamnaceae or Thymelaeaceae and <10% sedges.

Floristics: *Protea repens*, *P. lorifolia*, *Anthospermum aethiopicum*, *Elytropappus gnaphaloides*, *Restio gaudichaudianus*, *Hypodiscus striatus*, *Passerina pendula*, *R. triticeus*, *Stoebe* sp., *Phylica* sp. (*P. confusa*?) and *Erica* sp.

Distribution: C, SC & SI (Fig. 49).

Environment: See Gymanshoek Pd. Soils are usually deep (0.7–1.0 m) and relatively rock-free (mostly <25% cover). Rainfall is often low (<700 mm p.a.). *Protea lorifolia* appears to occur on the shallower soils.

Synonymy: Bond's (1981) *Protea lorifolia*–*Simocheilus multiflorus* Community is an example of Congo.

Benetive Dry Proteoid Fynbos (Type Pd5)

Stratification: 32 to 63.

Formation: Low, mid-dense, restioid, leptophyllous shrubland with a sparse or occasionally mid-dense, tall, proteoid overstorey.

Differentiating features: Benetive and Thomas Pd both have understoreys approaching Restioid Fynbos, but Benetive is distinguished by the dominance of *Protea*

laurifolia. The proteoids are taller in Benetive than in Thomas, and Benetive, being more xeric, shares some features with the preceding types (e.g. >10% orthophyllous shrubs, net-veined geophytes and aphyllous grasses). Restioid cover is mostly >30% and non-proteoid shrub cover is usually <50%.

Floristics: *Protea laurifolia*, *Leucospermum wittebergensis*, *Hypodiscus argenteus*, *H. striatus*, *Thamnochorus dichotomus*, *Restio gaudichaudianus*, *Pentameris dregeana*, *Restio filiformis*, *Anthospermum aethiopicum*, *Clutia alaternoides*, *Aristea* sp. and *Tetraria* sp.

Distribution: C (Fig. 49).

Environment: See Weltevrede Pd and Hawequas Pd. Rainfall usually averages more than 1 000 mm p.a. and soils are mostly deep colluvial soils of Glenrosa, Hutton and Clovelly Forms.

Thomas Dry Proteoid Fynbos (Type Pd6)

Stratification: 42, 43.

Formation: Low to mid-high, mid-dense to closed, restioid, leptophyllous shrubland with a sparse to open, mid-high (occasionally tall) proteoid overstorey.

Differentiating features: Apart from its understorey being dominated by restioids and its specific set of proteoid dominants, there are few other features that distinguish Thomas. Ararat, Thomas and Benetive are the types which most often have a high cover of narrow-leafy sedges (>5%). Cover of Ericaceae is usually between 10% and 30% in Thomas.

Floristics: *Protea repens*, *P. lorifolia*, *P. eximia*, *Restio triticeus*, *R. filiformis*, *R. hystrix*, *R. fruticosus*, *R. sejunctus*, *Hypolaena purpurea*, *Hypodiscus striatus*, *H. albo-aristatus*, *Metalasia muricata*, *Agathosma mucronulata*, *Tetraria fourcadei*, *Elegia parviflora*, *T. cuspidata* and *T. ustulata*.

Distribution: C, SW & SI (Fig. 49).

Environment: See Gymanshoek Pd. Relative to other types of Dry Proteoid Fynbos, soils are quite shallow (mostly 0,2–0,5 m, mostly Mispah Form). Rainfall ranges from 600 mm to 2 000 mm p.a. on average.

Ararat Dry Proteoid Fynbos (Type Pd7)

Stratification: 56, 43.

Formation: Low to mid-high, mid-dense, restioid, ericaceous shrubland with a sparse, mid-high proteoid overstorey.

Differentiating features: The major differentiating feature is the high cover of Ericaceae (often >40%). Penaeaceae are also usually present (up to 20% cover). Other differentiating features are >5% fine aphyllous sedges and aphyllous shrubs.

Floristics: *Protea repens*, *P. eximia*, *Penaea mucronata*, *Erica* spp., *Tetraria ustulata*, *T. involucreta*, *T. cuspidata*, *Chondropetalum paniculatum*, *Staberoha cernua*, *Tham-*

nochorus gracilis, *Hypodiscus aristatus*, *H. synchroolepis*, *Pentaschistis* sp. and *Leucadendron salignum*.

Distribution: SI & SC (Fig. 49).

Environment: Ararat is at the mesic end of the moisture gradient in Dry Proteoid Fynbos. It often occupies south aspects. Soils are of the Mispah, Glenrosa or Cartref Forms.

Mesic Proteoid Fynbos (Subseries Pm) (Tables 20 & 23)

Differentiating features: Apart from the characteristic proteoid dominants of Mesic Proteoid Fynbos (Table 19), there are few other diagnostic features. Relative to Dry Proteoid Fynbos, there is usually more cover in the taller strata. Restioid-like ferns and lobed-leaved proteoids are low-constancy differential features of Mesic Proteoid Fynbos. This subseries shares many features with Dry and Mesotrophic Proteoid Fynbos features which are lacking in Wet Proteoid Fynbos. These include low non-mat proteoids (especially nanophyllous), >5% narrow-leafy sedges, >10% geophytes and aphyllous shrubs. Ferns, climbers and >5% orthophyllous shrubs are more or less lacking in Mesic Proteoid Fynbos but are found in all the other subseries. The many features shared by Mesic and Wet Proteoid Fynbos are discussed under the latter. The dominant proteoids of Mesic Proteoid Fynbos are *Protea nerifolia*, *P. punctata*, *Leucadendron eucalyptifolium*, *L. uliginosum* and *L. loeriense*. Of these, *L. eucalyptifolium* is also a common dominant in Wet Proteoid Fynbos. Only when *L. eucalyptifolium* is a co-dominant with *P. nerifolia*, or when it occurs without *P. aurea* or without a high cover of *Berzelia* spp., does it indicate Mesic Proteoid Fynbos. In Dry Proteoid Fynbos there are a considerable number of examples in which the understorey approaches Asteraceous Fynbos, whereas in Mesic Proteoid Fynbos there are few such examples. On the other hand, Proteoid Fynbos with an ericaceous understorey is rare in Dry Proteoid Fynbos but common in Mesic Proteoid Fynbos.

Distribution: Chiefly SI & SC (Fig. 51).

Environment: Mesic Proteoid Fynbos, like Wet Proteoid Fynbos, is chiefly a community of the south but it is not as restricted to the coastal mountains. Soils average 0,6 m deep with 46% total rock cover. This subseries occurs at higher altitudes than Wet Proteoid Fynbos. Rainfall averages 850 mm p.a. The xeric-mesic gradient from Dry Proteoid Fynbos to Wet Proteoid Fynbos is largely accounted for by geographical distribution, with Dry Proteoid Fynbos occurring in the dry north-west and Wet Proteoid Fynbos occurring in the cool moist southern coastal areas, often associated with phreatic sites. There is also a gradient of aspects, with Dry Proteoid Fynbos tending to be found on north aspects and Wet Proteoid Fynbos more associated with south aspects.

Jonkershoek Mesic Proteoid Fynbos (Type Pm0)

Stratification: 65, 66.

Formation: Tall, open to closed, proteoid shrubland with a sparse to open, mid-high shrub layer.

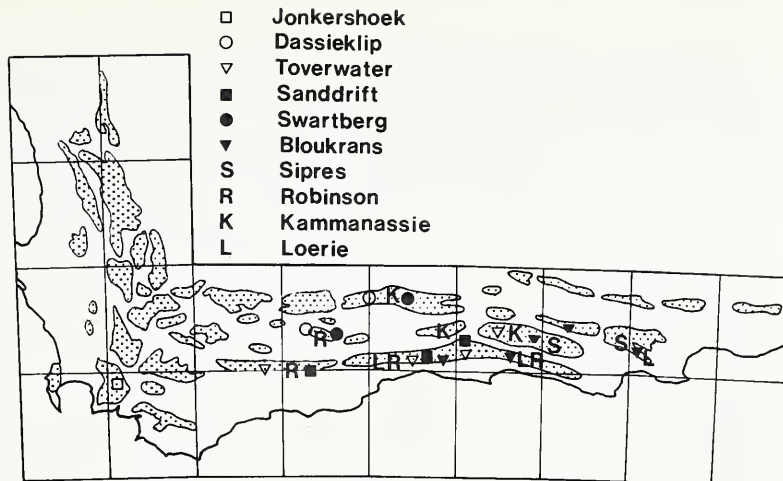


FIG. 51.—Distribution of Mesic Proteoid Fynbos.

Differentiating features: The understorey features of Jonkershoek place this type close to Fisantkraal Dry Fynbos (e.g. plumose restioids, high orthophyllous shrub cover). Other mesic differentiating characters of this *Protea neriifolia*-dominated type are ferns and cupressoids.

Floristics: *Protea neriifolia*, *Widdringtonia nodiflora*, *Cannomois virgata*, *Cliffortia cuneata*, *Brunia nodiflora* and *Pteridium aquilinum*.

Distribution: SW (Fig. 51).

Environment: As with Fisantkraal Ao, Jonkershoek occurs under relatively rare conditions viz at high rainfall (averaging about 3 000 mm p.a.) and on deep soils (>1.0 m) that have fine textures (e.g. granite-derived soils of Hutton Form). The other types of Mesic Proteoid Fynbos that are dominated by *P. neriifolia* do not occur on such deep, rock-free, fine-textured soils.

Dassiëklip Mesic Proteoid Fynbos (Type Pm1)

Stratification: 42, 63.

Formation: Mid-high, open, proteoid shrubland with a low to mid-high, leptophyllous shrub layer.

Differentiating features: The understorey to *Protea punctata* in Dassiëklip is a well-developed shrub layer with some affinities to Fisantkraal Ao (e.g. high orthophyllous cover, Bruniaceae). Stoeboids have a high cover (>10%) and stem spinescence may be high (e.g. >40%).

Floristics: *Protea punctata*, *Brunia nodiflora*, *Stoebe plumosa*, *Erica* sp., *Restio sejunctus*, *Elegia parviflora* and *Stoebe cinerea*.

Distribution: SI (Fig. 51).

Environment: Dassiëklip occurs at high altitudes (over 1 200 m) under relatively low rainfall (averaging 600 mm to 700 mm p.a.). The soils are quartzite derived, deep, without high rock cover and are usually of Cartref, Oakleaf or Hutton Forms.

Synonymy: Bond (1981) describes a Transitional *Protea punctata*–*Brunia nodiflora* Community and it is best placed in Dassiëklip.

Toverwater Mesic Proteoid Fynbos (Type Pm2)

Stratification: 42 to 56.

Formation: Low to mid-high, mid-dense to closed, restioid, leptophyllous shrubland with a sparse to mid-dense, mid-high to tall, proteoid overstorey.

Differentiating features: In this *Protea neriifolia*-dominated community, the understorey is restioid. Toverwater differs from the other restioid types by generally having >5% fleshy-leaved shrubs, a high constancy of coarse aphyllous sedges and a high cover of evergreen mesomacrophyllous geophytes and broad leptophyllous shrubs. Grass cover >5% is more constant in Toverwater than in other types. Tall restioids (1.0–1.5 m) are mostly a feature of Toverwater and Sanddrift. Unlike the other types of restioid Mesic Proteoid Fynbos and ericaceous Mesic Proteoid Fynbos, Toverwater usually has <20% Ericaceae.

Floristics: *Protea neriifolia*, *Hypodiscus synchroolepis*, *H. striatus*, *H. argenteus*, *Cannomois dregei*, *Restio triticeus*, *R. fruticosus*, *Hypolaena spathulata*, *Lanaria lanata*, *Tetraria capillacea*, *T. fasciata*, *T. exilis*, *Phyllea lachneaeoides*, *Erica* spp. and *Leucadendron salignum*.

Distribution: SC (Fig. 51).

Environment: Relative to the *Protea neriifolia*-dominated Type in which Ericaceae are predominant in the understorey (Sipres Pm), this restioid type is found under lower-rainfall conditions or on more northerly aspects.

Sipres and Toverwater occur under less mesic conditions than the types dominated by *Protea neriifolia*, *Leucadendron eucalyptifolium*, *L. uliginosum* or *L. loeriense*. The *L. uliginosum* or *L. loeriense* types are often found at higher altitudes and rainfall than the *P. neriifolia*/*L. eucalyptifolium* types, but probably as important in differentiating these two set of types are the soil characters. The *L. uliginosum* and *L. loeriense* types are

usually restricted to soils of Cartref Form that are generally shallow (median of 0,3 m), whereas the *P. neriifolia*/*L. eucalyptifolium* types are often on deeper soils of Oakleaf, Clovelly, Glenrosa, Hutton and Mispah Forms. The *P. neriifolia* types are also found on these latter soils; soils of Cartref Form being only rarely present under *P. neriifolia*.

Synonymy: Bond's (1981) *Protea neriifolia*–*Erica viridescens*–*Hypodiscus synchroolepis* Community is equivalent to Toverwater.

Sanddrift Mesic Proteoid Fynbos (Type Pm3)

Stratification: 42 to 65.

Formation: Mid-dense to closed, mid-high to tall, proteoid shrubland with a low to mid-high, closed, restioid, leptophyllous shrub layer.

Differentiating features: *Protea neriifolia* and *Leucadendron eucalyptifolium* are co-dominants in this type and the understorey is essentially restioid. The understorey, as in some types of ericaceous Mesic Proteoid Fynbos, is often quite tall (>1,5 m). Bobartioid geophytes are not a feature of this community, but are relatively constant in the ericaceous Mesic Proteoid type that is dominated by *P. neriifolia* and *L. eucalyptifolium*.

Floristics: *Leucadendron eucalyptifolium*, *Protea neriifolia* (occasionally *L. eucalyptifolium* is co-dominant with *P. lorifolia*), *Erica brownleeae*, *E. nemorosa*, *Penaea* spp., *Hypodiscus synchroolepis*, *Restio compressus*, *Hypolaena spathulata*, *Elegia juncea*, *R. hystrix*, *Phyllica* spp., *Hypodiscus aristatus*, *Tetraria ustulata* and *T. fasciata*.

Distribution: SC (Fig. 51).

Environment: Sanddrift is environmentally differentiated from the ericaceous type which has the same proteoid overstorey (Robinson Pm), by generally being found at lower altitudes and rainfall and on more northerly aspects (see also Toverwater Pm).

Swartberg Mesic Proteoid Fynbos (Type Pm4)

Stratification: 43, 63.

Formation: Mid-high to tall, open to mid-dense, proteoid shrubland with a low, mid-dense, restioid, leptophyllous shrub understorey (Fig. 52).

Differentiating features: This type has a restioid understorey and is dominated by *Protea punctata*, or occasionally by *Leucadendron comosum*. There are few other differentiating features.

Floristics: *Protea punctata*, *Leucadendron comosum*, *Erica* spp., *Elegia parviflora*, *Hypodiscus synchroolepis*, *Leptocarpus rigidus* and *Tetraria fourcadei*.

Distribution: SI (Fig. 51).

Environment: Swartberg is found on more northerly slopes and at lower rainfall and altitude than Kammanassie Pm (in which *Protea punctata* is also dominant but which has an ericaceous understorey). Swartberg and Kammanassie have much higher rock cover than the *P. punctata*-dominated Dassieklip Type. Swartberg and Kammanassie occur at altitudes above 1400 m. The *P. punctata* types are all characteristic of the highest altitudes. The soils in Swartberg are of the Clovelly and Mispah Forms, and it appears that Clovelly soils are important in all the *P. punctata* types.



FIG. 52.—Swartberg Mesic Proteoid Fynbos. *Protea punctata* forms the canopy to a predominantly restioid understorey. The dominants in the understorey include *Hypodiscus synchroolepis*, *Leptocarpus rigidus*, *Tetraria fourcadei* and *Erica* sp. Swartberg, c. 1600 m on north slopes.



FIG. 53.—Sipres Mesic Proteoid Fynbos. *Protea neriifolia* forms the overstorey to the ericaceous understorey. Otterford Forest Station, c. 380 m.

Bloukrans Mesic Proteoid Fynbos (Type Pm5)

Stratification: 42 to 56.

Formation: Sparse to mid-dense, mid-high to tall, proteoid shrubland with a low to mid-high, mid-dense to closed, restioid, sedge and leptophyllous shrub understorey.

Differentiating features: This type is dominated by *Leucadendron uliginosum* or *L. loeriense* and it has a restioid understorey. The understorey generally has a much lower cover of non-proteoid shrubs than the other types of restioid Mesic Proteoid Fynbos.

Floristics: *Leucadendron uliginosum*, *L. loeriense*, *Hypolaena spathulata*, *Cannomois dregei*, *Restio triticeus*, *Hypodiscus striatus*, *H. albo-aristatus*, *H. synchroolepis*, *Erica melanthera*, *Penaea cneorum*, *E. scytophylla*, *Tetraria fourcadei*, *T. fimbriolata* and *Lanaria lanata*. *Protea neriifolia* is occasionally present but it always has much less cover than either *L. uliginosum* or *L. loeriense*.

Distribution: SI & SC (Fig. 51).

Environment: Rainfall ranges from 500 mm to 1 200 mm p.a. in Bloukrans whereas in Loerie Pm, the ericaceous type with a similar overstorey, rainfall is slightly higher (700 mm to 1 400 mm p.a.). If Loerie and Bloukrans occur on the same transect then Loerie occupies more southerly aspects and the soils of Bloukrans are not as consistently of Cartref Form (e.g. often of Mispah or Glenrosa Form; see also Toverwater Pm).

Sipres Mesic Proteoid Fynbos (Type Pm6)

Stratification: 56, 63.

Formation: Mid-dense to closed, mid-high to tall, proteoid shrubland with a low to mid-high, closed, restioid, ericaceous shrub layer (Fig. 53).

Differentiating features: Sipres is dominated by *Protea neriifolia* and has a tall understorey (>1,5 m) with high Ericaceae cover.

Floristics: *Protea neriifolia*, occasionally *P. punctata* with lower cover than *P. neriifolia*, *Restio sejunctus*, *R. gaudichaudianus*, *R. triticeus*, *Hypodiscus striatus*, *Elegia parviflora*, *Erica hispidula* (and other *Erica* spp.), *Tetraria fourcadei*, *T. fasciata*, *Ehrharta dura* and *Lanaria lanata*.

Environment: See Toverwater Pm.

Robinson Mesic Proteoid Fynbos (Type Pm7)

Stratification: 63, 56.

Formation: Mid-dense to closed (sometimes open), tall to mid-high, proteoid shrubland with a low to mid-high, closed, restioid, ericaceous shrub layer.

Differentiating features: *Leucadendron eucalyptifolium* and *Protea neriifolia* are the proteoid dominants in this community which has high Ericaceae cover especially in the 0,5–1,0 m layer. Restioid-like ferns appear to be a low-cover, low-constancy feature of Sipres and Robinson.

Floristics: *Leucadendron eucalyptifolium*, *Protea neriifolia*, *Penaea cneorum*, *Erica* spp. (including *E. cordata* var. *arachnoidea*, *E. adunca*, *E. melanthera*), *Struthiola eckloniana*, *Tetraria fasciata*, *T. exilis*, *Hypodiscus striatus*, *H. aristatus*, *Restio compressus*, *Elegia vaginulata*, *Ehrharta dura* and *Merxmüllera rufa*.

Distribution: SC (Fig. 51).

Environment: See Sanddrift Pm and Toverwater Pm.

Synonymy: Bond's (1981) *Protea neriifolia*–*Leucadendron eucalyptifolium*–*Erica triceps* Community would be classed as Robinson.

Kammanassie Mesic Proteoid Fynbos (Type Pm8)

Stratification: 43.

Formation: Low to mid-high, sparse to closed, restioid, ericaceous shrubland with a sparse (to sometimes mid-dense), mid-high to tall, proteoid overstorey.

Differentiating features: *Protea punctata* dominates in this type. The understorey has a high cover of Ericaceae and there is more cover in the lower height classes (0–0,5 m) relative to that in the other types that have an ericaceous understorey.

Floristics: *Protea punctata* (occasionally also *Leucadendron album*), *Erica* spp., *Tetraria capillacea*, *Restio sejunctus*, *R. hystrix*, *Elegia vaginulata*, *Willdenowia teres*, *Hypodiscus albo-aristatus* and *Cliffortia* sp.

Distribution: SI (Fig. 51).

Environment: See Swartberg Pm and Toverwater Pm. Soils are of the Glenrosa, Clovelly or Mispah Forms.

Loerie Mesic Proteoid Fynbos (Type Pm9)

Stratification: 42 to 56.

Formation: Open to mid-dense, mid-high to tall, proteoid shrubland with a low to mid-high, mid-dense to closed, restioid, sedge, ericaceous and penaeoid understorey (Fig. 54).

Differentiating features: In this type, *Leucadendron uliginosum* or *L. loeriense* are the dominants and the understorey approaches Ericaceous Fynbos. However, Ericaceae cover is lower (20–40%) than in the other types of ericaceous Mesic Proteoid Fynbos. Penaeaceae are often high in Loerie (cover >30%).

Floristics: *Leucadendron uliginosum* or *L. loeriense*, *Penaea cneorum*, *Erica* spp. (including *E. viridescens* and *E. scytophylla*), *Tetraria fasciata*, *T. flexuosa*, *T. capillacea*, *Hypodiscus albo-aristatus*, *H. striatus*, *Restio compressus*, *R. triticeus*, *Elegia racemosa*, *E. thyr-sifera* and *Lanaria lanata*.

Distribution: SC (Fig. 51).

Environment: See Bloukrans Pm and Toverwater Pm. Soils are always of the Cartref Form.

Synonymy: Some of Bond's (1981) *Erica viridescens*–*Hypodiscus aristatus* Community would be placed in Loerie.

Wet Proteoid Fynbos (Subseries Pw) (Tables 20 & 24)

Differentiating features: The major dominant canopy species of Wet Proteoid Fynbos are *Protea aurea*, *P. mundii*, *Leucadendron eucalyptifolium* and *L. conicum*. In addition, a number of characters are differential including >10% orthophyllous shrubs, >5% non-proteoid microphyllous shrubs, >5% tall non-proteoid nanophyllous shrubs, tall usually plumose restioids, >80% above 2 m, non-proteoid mesophyllous shrubs and >5% climbers. Mesic and Wet Proteoid Fynbos share many features especially Penaeaceae, Bruniaceae, >20% sedges, >80% graminoids, >5% wide leafy sedges, >40% Ericaceae and creeping forbs. *Pteridium aquilinum* is a feature of this subseries and of Mesotrophic Proteoid Fynbos. Much of the tallest and most closed Proteoid Fynbos is represented in Wet Proteoid Fynbos. In all types there is 100% total cover, and many types are over 5 m tall.

Distribution: Chiefly SC (Fig. 55).

Environment: Of all Proteoid Fynbos, this subseries occurs on the deepest (0,9 m) and least rocky (3%) soils. It occurs mainly on the south-facing foothill slopes. Rainfall averages over 1 000 mm p.a., and altitudes average 700 m.



FIG. 54.—Loerie Mesic Proteoid Fynbos. The spindly, nanophyllous proteoid dominating the overstorey is *Leucadendron uliginosum*. The understorey is predominantly ericaceous, the dominants including *Erica viridescens*, *Elegia racemosa*, *Staberoha cernua*, *Lanaria lanata*, *Metalasia muricata* and *Tetraria fasciata*. Ruiterbos Peak, Outeniqua Mountains, c. 1 100 m.

TABLE 24.—Differentiated table for the types of Wet Proteoid Fynbos. See Table 8 for notes on characters and conventions used

	Wet Proteoid Fynbos																			
	Outeniqua				Otterford				Mangold						Kouma					
	Plot numbers																			
	508	334	340	332	252	395	385	327	303	323	304	483	288	310	289	296	295	354	270	333
† Ericaceae >3	8	5		6	6												5			
† Lobed-leaved, non-proteoid		*		0																
Sedge, aphyllous, coarse		*	0																	
Fern, <i>Pteridium aquilinum</i> >0				1	2							1						1		
Geophyte, evergreen, meso-macrophyllous >0	1	1																		
Forb, rosette					*	*	+													
† Fleshy-leaved >*					0			0												
† Woody plant, <0.25 m		*	*		*	0		0												
# Total cover, 1–1.5 m >5	9		9		7	6														
Grass, sclerophyllous wide			1	1				1												
Grass, aphyllous			0					0												
Sedge >*	2	0			4			1		0	3	0	4	3	1	2	4			
† Penaeaceae	1		2		1	0				0	0	0	0	1	1	2	0	0		
Sedge, aphyllous, fine								1		0	0	4		*	2	4		*	*	
† Bruniaceae, not cupressoid-like					0	0	*			6	2	1	6	1	1					
† Ericaceae, broad-leaved								3		4						3	5			
Climber, parasitic forb					2							0	1	1						
† Ericoid-leaved (Rhamnaceae, Thymelaeaceae) >1										4	4							4		
† Proteoid, mesophyllous (non-mat) >*																0	0			
† Cupressoid						*										1	1			
# Total cover, 0.5–1 m >1	9	7	3	7	9	5		3	3	6	3	3		8		9	9			
Geophyte, evergreen, meso-macrophyllous		1	1	*	*	0		0	*		0	*		0	*	0	0			
Grass	*	1	0	1		*	2	0			1	*		0	*	*	*	0		
† Leptophyllous, broad (non-fleshy)		1	1		1			3				3				3	5			
† Ericoid-leaved (Asteraceae)			+					+		*	*									
† Microphyllous, non-proteoid >1																		2	3	7
† Total cover, 5–10 m								0										8		2
Restioid, plumose					0	4	2	*	0		*		4		1			1	0	*

† = woody plants; # = woody and herbaceous plants; 'no symbol' = herbaceous plants; + = less than 1% cover; * = 1–5%; 0 = 5–10%; 1 = 10–20%; 2 = 20–30%; 3 = 30–40%; 4 = 40–50%; 5 = 50–60%; 6 = 60–70%; 7 = 70–80%; 8 = 80–90%; 9 = greater than 90%.

Synonymy: Kruger (1979a) provides a brief description of Wet Proteoid Fynbos under his broad-sclerophyllous scrub and his mixed sclerophyllous scrub. The former corresponds to Outeniqua Pw and Otterford Pw and the latter corresponds to Mangold Pw.

Outeniqua Wet Proteoid Fynbos (Type Pw1)

Stratification: 63.

Formation: Closed, tall, proteoid shrubland with a mid-high to low, closed, leptophyllous shrub understorey (Fig. 56).

Differentiating features: This type, dominated by *Leucadendron eucalyptifolium* and *Protea aurea*, has a dense shrub understorey (often cover >30%) that is mostly ericaceous. Restioids often have over 40% cover. Differential features include the high cover of Ericaceae, coarse aphyllous sedges, >10% *Pteridium aquilinum*, and >10% evergreen meso-macrophyllous geophytes. Bruniaceae are not a feature of Outeniqua. One plot in which *P. laticolor* was dominant was also placed in Outeniqua.

Floristics: *Protea aurea*, *Leucadendron eucalyptifolium*, *Laurophyllus capensis*, *Pteridium aquilinum*, *Penaea*

neorum, *Erica* spp. (including *E. adunca*, *E. brevifolia*, *E. viridescens*), *Ehrharta dura*, *Tetraria fasciata*, *Restio hystrix*, *Phyllica pinea*, *Acmadenia tetragona* and *Elegia vaginulata*.

Distribution: SC (Fig. 55).

Environment: Soils are characteristically deep (>1.0 m), of the Hutton and Clovelly Forms and are well-drained.

Otterford Wet Proteoid Fynbos (Type Pw2)

Stratification: 63 to 66.

Formation: Mid-dense to closed, tall, proteoid shrubland with a mid-high to low, closed, restioid, leptophyllous understorey.

Differentiating features: *Protea mundii* is the dominant in Otterford, or occasionally *P. mundii* and *Leucadendron eucalyptifolium* are co-dominants. Characteristic features include rosette forbs and >5% fleshy-leaved shrubs. Plumose restioids are usually present in Otterford (1–50% cover) but are often absent from Outeniqua Pw. The understorey of Otterford approaches Ericaceous Fynbos or some type of wet shrubland.

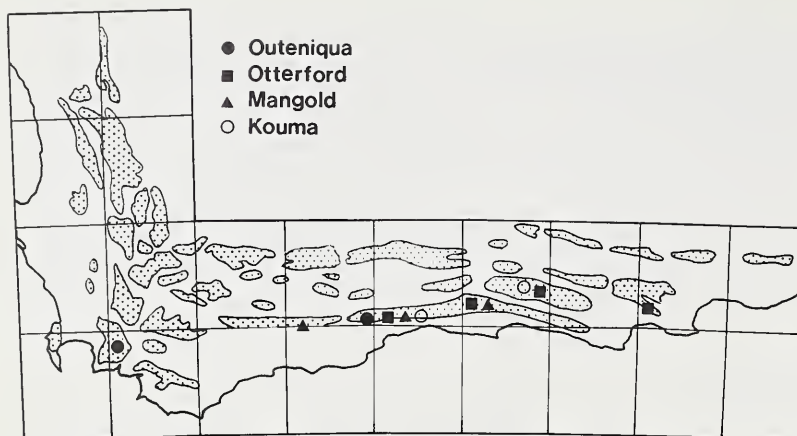


FIG. 55.—Distribution of Wet Proteoid Fynbos.

Floristics: *Protea mundii*, *Leucadendron eucalyptifolium*, *Erica* spp. (including *E. viridescens*, *E. hispidula*, *E. copiosa*), *Laurophyllus capensis*, *Agathosma ovata*, *Cliffortia ilicifolia*, *Cannomois virgata*, *Penaea cneorum*, *Lobelia neglecta* and *Elegia vaginulata*.

Distribution: SC (Fig. 55).

Environment: This type occupies more protected sites than Outeniqua Pm and may be found along rivers and streams. It is often at higher altitudes than Outeniqua. Soils are variable and may be of the Dundee, Oakleaf, Swartland, Cartref or Glenrosa Forms.

Mangold Wet Proteoid Fynbos (Type Pw3)

Stratification: 63.

Formation: Mid-dense to closed, tall, proteoid and bruniaceous shrubland with a mid-high to low, closed, restioid and/or leptophyllous shrub understorey (Fig. 57).

Differentiating features: The dominant proteoid in Mangold is *Leucadendron eucalyptifolium* and *Berzelia* spp. (often *B. intermedia*) are also dominant (10–70%). Occasionally *Berzelia* spp. are absent but then other characters of wet habitats are present (e.g. broad-leaved Ericaceae, ferns, cupressoids and sprawling restioids). The understorey of Mangold approaches Wet Ericaceous Fynbos. Sedges are consistently high in cover (5–50%) and Penaeaceae are always present (5–30%). Unlike other types, Mangold has almost no cover below 0,25 m height.

Distribution: SC (Fig. 55).

Floristics: *Leucadendron eucalyptifolium*, *Berzelia intermedia*, *B. burchelli*, occasionally *P. mundii* as a sub-dominant, *Widdringtonia nodiflora*, *Erica* spp. (including *E. cordata* var. *arachnoidea*), *Blechnum tabulare*, *Gleichenia polypodioides*, *Pteridium aquilinum*, *Restio anceps*, *R. compressus*, *Hypolaena spathulata*, *Elegia thyrsoifera*, *Tetraria triangularis*, *Epischoenus* sp. and *Cassytha ciliolata*.



FIG. 56.—Outeniqua Wet Proteoid Fynbos. *Leucadendron eucalyptifolium* (finer leaves) and *Protea aurea* form the canopy in the 5 m tall vegetation. The understorey is dominated by *Acmaenia tetragona*, *Phylla axillaris*, *Lanaria lanata* and *Pteridium aquilinum*. Ruitersbos Forest Station, Outeniqua Mountains, c. 500 m.

FIG. 57.—Mangold Wet Proteoid Fynbos. *Leucadendron eucalyptifolium* is the tall dominant proteoid, *Berzelia intermedia* is a dominant subcanopy species, and in the understorey are *Erica* sp., *Epischoenus* sp., *Restio* sp. and *Caesia contorta*. Mangold se pad, Tsitsikamma Mountains, c. 400 m.



Environment: Mangold occupies more mesic, less well-drained sites than Outeniqua and soils may often be of the Champagne Form.

Kouma Wet Proteoid Fynbos (Type Pw4)

Stratification: 66, 76.

Formation: Tall to very tall, closed shrubland (or low forest) with a sparse understorey.

Differentiating features: *Leucadendron conicum* is the dominant in Kouma. The understorey of Kouma is predominantly shrubby with only 5–30% restioid cover and very little cover below 1.0 m. Features found in the other types of Wet Proteoid Fynbos that are lacking in Kouma include evergreen meso-macrophyllous geophytes, grasses and broad leptophylls. Differentiating features of Kouma are the high cover of non-proteoid microphylls (>20%) and the very tall stature of the vegetation (mostly >5 m).

Floristics: *Leucadendron conicum*, *Rhus lucida*, *Buddleja salviifolia*, *Pteridium aquilinum*, *Cunonia capensis*, *Cliffortia odorata*, *Halleria lucida*, *Diospyros hirsuta*, *Passerina falcifolia*, *Virgilia oroboides* and *Empleurum serrulatum*.

Distribution: SC & SI (Fig. 55).

Environment: Kouma is characteristic of the streams of the southern coastal mountains. It occurs below 900 m but above the altitude of the forest-lined rivers and streams. Soils of Dundee and Fernwood Forms are common.

Synonymy: Taylor (1978) mentions a community dominated by *Leucadendron conicum*, but he includes it as a variation of the *Brabejum* Community which I place in Closed-Scrub Fynbos.

Discussion

Relationships to other communities

Mesotrophic Proteoid Fynbos approaches Grassy Fynbos and it appears that some types of Grassy Fynbos were formerly much more proteoid, the proteoids having been removed through frequent burning. The distinction between some types of Dry Proteoid Fynbos and Mesic Proteoid Fynbos on the one hand, and Mesotrophic Asteraceous Fynbos, Wuppertal Oligotrophic Asteraceous Fynbos, Winterhoek Dry Restioid Fynbos and Kouga Mesic Restioid Fynbos on the other is extremely arbitrary. The essential diagnostic feature is the presence or absence of greater than 10% tall seed-regenerating proteoids. The non-proteoid types are generally more a feature of shallower soils, but greater fire frequencies or out-of-season fires have probably played a role in the conversion of Proteoid Fynbos to non-proteoid fynbos. Similar relationships occur between some facies of Landdros Ericaceous Fynbos and Kammanassie Mesic Proteoid Fynbos. The Ericaceous Fynbos tends to occur at higher altitudes (e.g. in the Swartberg) but fires have probably also played a role.

Although some types of Proteoid Fynbos show the above relationships, other types are distinct and do not intergrade with Grassy, Asteraceous, Restioid or Ericaceous Fynbos. This applies especially to more mesic types of Mesic Proteoid Fynbos, especially those in which *Leucadendron eucalyptifolium* and *Protea neriifolia* are co-dominants, and to all the types in Wet Proteoid Fynbos.

Wet Proteoid Fynbos, in particular Kouma, shows relationships to non-fynbos. For instance, it often has forest trees and the proteoids reach the stature of short trees. Kouma is also similar to Witriver Closed-Scrub Fynbos and there is a gradient between Kouma and Witriver. Mangold Wet Proteoid Fynbos with its high cover

of Bruniaceae and its association with very damp, somewhat waterlogged, conditions, grades into Keurbos Wet Ericaceous Fynbos. The latter is associated with more extreme waterlogged conditions and always occurs on soils of Champagne Form.

Problems with the concept of Proteoid Fynbos

The most obvious problem for the concept of Proteoid Fynbos is the effect of fire in often eliminating or reducing proteoid cover. This problem is inherent in structural classification and is not easily overcome. It should be noted that frequent burning or out-of-season fires do not only have an effect on proteoids. Other seed-regenerating shrubs such as most Ericaceae are also affected, but the effect is much less noticeable. So the fire problem pervades the whole classification and another series which is probably affected is Ericaceous Fynbos. If one has *a priori* knowledge that a certain stand of fynbos was previously proteoid, it is likely that the proteoid classification could be applied by using the non-proteoid characters, as most of the types are relatively well-defined by particular sets of non-proteoid features.

Another problem in the concept of Proteoid Fynbos

is the relatively arbitrarily selected criterion for distinguishing Proteoid Fynbos i.e. the 10% cover of proteoids. Some support for the 10% level comes from the work of Bond (1981). His numerically-defined proteoid group is diagnosed by the 10% cover level. Users of the classification should be flexible regarding the 10% level and therefore, for example, it would be acceptable and practical to map Wuppertal Restioid Dry Fynbos as including a proteoid cover of from 1% to about 20%. If the proteoid cover was generally over 10% and varied from 1% to 40%, then one would map as Proteoid Fynbos. There is no problem with varying the cut-off level, because if one uses a 20% level, then the vegetation with 10 to 20% cover of proteoids could be easily fitted into the non-proteoid classification. If a 20% proteoid criterion had been used in the classification, about 30% of the proteoid plots would not have been included in Proteoid Fynbos, but the classification would have remained largely unchanged. Three Proteoid Fynbos types, Kammanassie (*Protea punctata* with an ericaceous understorey), Weltevrede (*P. laurifolia* with an asteraceous fynbos understorey) and Cango (*P. repens* with an asteraceous fynbos understorey) would have had very few plots representing them and would perhaps have been merged with other non-proteoid types.

Closed-Scrub Fynbos (Series C)

The differentiation of the Closed-Scrub Fynbos Series into types is shown in Table 25. The diagnostic attributes of these types are used in Key 11, whereas the differentiating characters of communities associated with phreatic environments in general (Closed-Scrub Fynbos and other series) are given in Table 26 (see discussion of phreatic vegetation).

Witrivier Closed-Scrub Fynbos (Type C1)

Stratification: 66 (see Fig. 4, p.8).

Formation: Tall, mid-dense to closed, microphyllous shrubland.

Differentiating features: Characteristic of Witrivier is the high cover of tall microphyllous (non-proteoid) shrubs. There is usually a considerable degree of cover above 2 m height (often >70%). Mesophyllous shrubs are also characteristic and very wide-leafy sedges are relatively constant. Dwarsrivier C and Witrivier share a number of features including the presence of ferns, plumose restioids (1–50% cover) and, with lower constancy, aphyllous shrubs, aphyllous grasses, climbers and tall grasses (often over 1 m). Both types are taller than Meulrivier C.

Floristics: *Metrosideros angustifolia*, *Brachylaena neriifolia*, *Leptocarpus paniculatus*, *Brabejum stellatifolium*, *Elegia capensis*, *Erica caffra*, *Salix mucronata*, *Miscanthidium capense*, *Cyperus* sp., *Juncus lomatophyllus*, *Prionium serratum*, *Leucadendron salicifolium* and *Cannomois virgata*. Witrivier and Dwarsrivier are relatively predictable in terms of dominants. Very few fynbos types have this characteristic.

Distribution: NW, C, SW & SI (Fig. 58).

Environment: The deep substrate is mostly very rocky, but some stands were from rock-free river-banks. Witrivier is found at low altitudes (below 700 m). Dundee Form soils are common.

Synonymy: Witrivier is the only Closed-Scrub Fynbos that has been formally recognized by previous workers. It corresponds to the broad-sclerophyllous closed scrub of Kruger (1979a), the *Brabejum stellatifolium* Community of Taylor (1978); the *Brabejum stellatifolium* Community of Werger *et al.* (1972), the *Brabejum–Rhus* Riverine Scrub of Boucher (1978), and the *Metrosideros angustifolia* association of Campbell & Moll (1977).

Dwarsrivier Closed-Scrub Fynbos (Type C2)

Stratification: 43 to 65.

Formation: Mid-high to tall, open to mid-dense, leptophyllous shrubland often with an open cover of tall restioids.

Differentiating features: Dwarsrivier shares many features with Witrivier C but it lacks the high cover of tall mesophyllous shrubs and does not have as much cover in the taller height classes. More or less restricted to Dwarsrivier are leaf-spinescent shrubs, fleshy-leaved shrubs and stoeboids. Features not found in Witrivier, but common to Dwarsrivier and Meulrivier include a high woody cover in the lower height classes (<1,5 m), >30% restioids, >30% leptophylls, coarse aphyllous sedges, Bruniaceae and non-ericaceous ericoids.

Floristics: *Elegia capensis*, *Pteridium aquilinum*, *Stoebe plumosa*, *Restio rhodocoma*, *Juncus oxycarpus*, *Berzelia intermedia*, *Leptocarpus paniculatus*, *Cliffortia strobilifera* and *Helichrysum* spp. (e.g. *H. cymosum*).

Distribution: NW, C, SW, SC & SI (Fig. 58).

Environment: Dwarsrivier is found at higher altitudes than Witrivier (always >700 m) and rockiness is never as high as in Witrivier.

Meulrivier Closed-Scrub Fynbos (Type C3)

Stratification: 32 to 62.

Formation: Various shrublands and restioid shrublands.

KEY 11.—Key to the types of Closed-Scrub Fynbos

- 1. >10% microphyllous shrubs, <60% nanophyllous shrubs Witrivier Closed-Scrub Fynbos
- 2. >20% plumose restioids or >20% woody plants 2–5 m Dwarsrivier Closed-Scrub Fynbos
- 3. >20% in the 0–0.25 m height class or >30% in the 0.25–0.5 m height class Meulrivier Closed-Scrub Fynbos

TABLE 25.—Differentiated table for the types of Closed-Scrub Fynbos. See Table 8 for notes on characters and conventions used

	Closed-Scrub Fynbos																Meulrivier			
	Witrivier								Dwarsrivier											
	Plot numbers																			
	073	001	191	250	130	045	042	043	218	314	271	267	485	348			453	229	449	445
† Microphyllous, non-proteoid	5	6	5	4	7	9	1	4	1	*	1	1	0							
† Microphyllous, non-proteoid, 2–5 m	4	5	4	2	6	9	0	2	0	*	0	0								
# Total cover, 2–5 m >6		7	9	7	9	9		7												
† Microphyllous, non-proteoid, 1,5–2 m		1	1	1	1		0	1	*	*	*	*								
† Mesophyllous, non-proteoid		1	6	0	2				*								0			
Grass, sclerophyllous wide			+	2	0									0						
Sedge, leafy (very wide)							1	0	0	0		0								
† Total cover, 5–10 m			+	0		*		1												
† Spinescence, stem		*	+																	
† Spinescence, leaves									*		0	1	*	1					0	
† Fleshy-leaved										1	*	*	*					*		
† Ericoid-leaved (Asteraceae)													3	1						
† Woody plant, 2–5 m	5	6	9	3	7	9	1	6	1	0	2	6	1	*			1		*	
Restioid, plumose		0	*	5	2	1	0	1	5	2	5		3	3			0			
# Total cover, 2–5 m >4	5	7	9	7	9	9		7			5	6								
Fern, pinnate-leaved		2	0		1	0		*	0	1	0	*	0				0			
Grass, 0,5–1 m			*	0			0	*	0				1	*	0					
† Woody plant, 1,5–2 m >0		1	2	2	1		1	2			3	1	3						1	
Fern, <i>Pteridium aquilinum</i>		2	*		0					1	0		0							
Grass, >1 m				1	0				2			0								
† Aphyllous			+		*					*			0							
Grass, aphyllous			*	*				*				2								
# Climber			*					*				*								
# Total cover, 0,25–0,5 m >2																	7	4	3	
# Total cover, <0,25 m >1																	5	2	2	
† Woody plant, 0,25–0,5 m >*																	4	1	0	
Sedge >2																	3	4		
† Woody plant, <0,25 m												*					2	*	2	
Graminoid, relative cover >4				5				6									7	5	5	
† Pubescent-leaved >5																	6			
† Woody plant, 0,5–1 m >0										1	1		1	1			1	2		
Restioid >2				5					5	3	5		3	3			3	9	5	
† Leptophyllous >3													8	5			7	4		
† Bruniaceae, not cupressoid-like													2	*			1	0		
Sedge, aphyllous, coarse										*	+						2	3		
† Woody plant, 1–1,5 m >1										2		4	4					4		
Grass, 0,25–0,5 m >*												0	0				1		1	
† Ericoid-leaved (Rhamn-, Thymelae- & Asteraceae)			*									3	1						1	
† Nanophyllous, non-proteoid >3							4			6	7						7			
† Pubescent-leaved >0										1	2						6		*	*
Graminoid, <0,1 m													*							
Sedge, leafy (narrow)									*			1					1			

† = woody plants; # = woody and herbaceous plants; 'no symbol' = herbaceous plants; + = less than 1% cover; * = 1–5%; 0 = 5–10%; 1 = 10–20%; 2 = 20–30%; 3 = 30–40%; 4 = 40–50%; 5 = 50–60%; 6 = 60–70%; 7 = 70–80%; 8 = 80–90%; 9 = greater than 90%.

Differentiating features: This is a heterogeneous type and is essentially a dumping ground for the diverse non-ericaceous riparian shrublands that do not fit the Witrivier C or Dwarsrivier C descriptions. Stature is low with most cover below 1–1,5 m (sometimes 2,0 m) and with high cover in the lower strata (0–0,5 m). Sedge cover may be high (>30%) and graminoid cover is usually high (>50%). One example had a very high cover of pubescent shrubs (>50%). Noticeably absent are such features as microphyllous shrubs, plumose restioids, ferns, mesophyllous shrubs and tall grasses.

Floristics: Very variable — *Erica* spp., *Merxmüllera stricta*, *Passerina falcifolia*, *Cliffortia burchellii*, *Elegia asperifolia*, *Empleurum serrulatum*, *Helichrysum petiolare* and *Ficinia* sp. cf. *F. gracilis*.

Distribution: SI (Fig. 58) but probably found elsewhere.

Environment: Meulrivier appears to be environmentally distinguished from the other types of Closed-Scrub Fynbos by the high altitude at which it is found (>1 400 m) and by its common association with shalebands.

TABLE 26.—Communities associated with phreatic environments

Differentiating characters	Types of Closed-Scrub Fynbos	Types of other series	Environmental characterization
Tall microphyllous shrubs dominant	Witrivier		<700 m altitude, streams, mostly not in the southern coastal mountains
non-protoid shrubs			
proteoid shrubs with Bruniaceae		Mangold Wet Proteoid Fynbos	<900 m, seepage areas, Oakleaf to Champagne Form soils, southern coastal mountains
without Bruniaceae			
<i>Leucadendron eucalyptifolium</i> / <i>Protea mundii</i> dominant		Otterford Wet Proteoid Fynbos	Streams and seepage areas, less waterlogging than Mangold Pw, southern coastal mountains
<i>Leucadendron conicum</i> dominant		Kouma Wet Proteoid Fynbos	<900 m, streams, Dundee and Fernwood Form soils, southern coastal mountains
Low and mid-high lepto-nanophyllous shrubs dominant			
Ericaceae + Bruniaceae >30%		Ruitersberg Wet Ericaceous Fynbos	>0,5 m Champagne Form soils, coastal mountains, seepage areas
Bruniaceae <20%		Keurbos Wet Ericaceous Fynbos	>1,0 m Champagne Form soils, coastal mountains, seepage areas, more mesic than Ruitersberg E.w and Mangold Pw
Bruniaceae >20%			>700 m altitude, streams
Ericaceae + Bruniaceae <25%			>1 400 m altitude, streams, often on shalebands
plumose restioids >10%, 2–5 m height class with >10%	Dwarsrivier		
plumose restioids <10%, 2–5 m height class with <10%	Meulrivier		
Graminoids dominant			
restioids dominant			
plumose restioids			
hummocky restioids		Crystal Azonal Restioid Fynbos	>1,0 m Fernwood Form soils, interior mountains, drainage lines
not as the above		Sneeuokop Azonal Restioid Fynbos	>1,0 m Champagne Form soils, coastal mountains, seepage areas
mostly short			
mostly tall		Fonteinjtjesberg Azonal Restioid Fynbos	>0,2 m Fernwood Form soils, seasonally waterlogged plateaux of interior and coastal mountains
grasses dominant		Wolfberg Azonal Restioid Fynbos	>0,4 m Fernwood Form soils, occasionally waterlogged plateaux of interior mountains
hummocky grasses			
not hummocky grasses		Waterkloof Grassland	>1,0 m non-red Oakleaf Form soils, interior mountains, drainage lines
		Engelseberg Mesic Grassy Fynbos	>1,0 m Champagne Form soils, coastal mountains, mist-swept mountain slopes

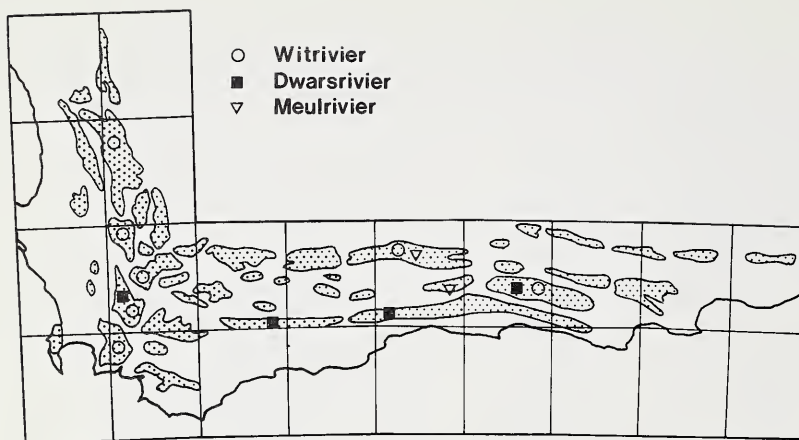


FIG. 58. — Distribution of Closed-Scrub Fynbos.

Discussion

Relationships to non-fynbos

Witrivier shows strong affinities with non-fynbos vegetation. It ranges from true fynbos with up to 60% restioids, 30% Ericaceae, or 20% proteoids to non-fynbos with no restioids, Ericaceae, or proteoids. One plot from Meulrivier (453) is also close to being non-fynbos. With its dominance of *Helichrysum petiolare*, this plot can probably be likened to the vegetation occurring on some streams in the afromontane region.

Phreatic vegetation

Not all vegetation of streams or phreatic sites necessarily belongs to Closed-Scrub Fynbos. Closed-Scrub Fynbos excludes those shrubland types which are dominated by the differentiating features of Ericaceous Fynbos or Proteoid Fynbos, and Closed-Scrub Fynbos excludes graminoid-dominated vegetation. In Table 26 all the communities that are associated with phreatic sites are summarized. Witrivier is the major stream community at low altitudes in the west and in the southern interior, whereas Wet Proteoid Fynbos is the major stream community in the southern coastal mountains.

Regional community complexes

In the previous chapters the communities of the mountains are described. Because of the rapid change of vegetation with altitude and aspect, and because of the rugged topography in the Fynbos Biome, it is often not possible to map the communities even at scales as large as 1:100 000. It is often only possible to map community complexes. Furthermore, for conservation and management planning, it is often necessary to consider community complexes rather than communities. In this chapter, I delineate mountain regions each of which has a characteristic combination of communities.

Methods

Of the 22 transects used in this project, the Bredasdorp transect had only two plots which were incorporated into the classification and this transect is not used here. The remaining transects had 10 to 42 classified plots, giving a total of 502 plots (5 of the 507 plots were deemed aberrant and were not incorporated into the classification). A two-way table of transects-by-communities was constructed by recording the number of plots placed in each of the communities on each transect. Because of the variability of sampling intensity between transects the numbers were relativized for each transect, thus giving a table showing the relative proportion of occurrence of the different communities on each transect. Communities of all hierarchical levels were represented in the table.

The table was sorted, using the Braun-Blanquet sorting technique so that groups of transects with similar communities, and groups of communities found in similar transects, were brought together. The sorting was based on various numerical classificatory techniques (polythetic agglomerative techniques, see below).

Results

Seven groupings of transects have been identified in Table 27. Each grouping represents a certain mountain region and is named accordingly e.g. Eastern (Mountain) Region (Fig. 5). A number of non-fynbos communities have been used to arrive at this classification. However, it can be seen from Table 27 that if the non-fynbos communities were removed, the groupings of transects and communities would remain unchanged and thus the

transect groupings could also be regarded as fynbos groupings e.g. the Eastern (Mountain) Fynbos Region.

The various numerical classificatory techniques gave similar results and essentially differentiated the same seven regions. One of the results is shown (Fig. 59). In this result transect RI is placed in the Central Mountain Region. This is probably owing to undersampling on the southerly aspects of the RI transect. Ericaceous Fynbos is more common on the southerly aspects and it is this community that would link RI with other transects of the South-Western Mountain Region. Fig. 60 shows an ordination of the transects. The regions recognized are clearly differentiated in the ordination and the RI transect is satisfactorily placed in the South-Western Mountain Region.

The mountain regions (Fig. 5)

The Eastern Mountain Region contains a large number of non-fynbos communities chiefly of the Grassland & Grassy Shrubland Group. Grassy Fynbos is also strongly represented, this region being the region to which Grassy Fynbos is largely confined. The Eastern Mountain Region is strongly differentiated from the other mountain regions (Figs 59 & 60), lending support to the separation of Eastern Fynbos from Mountain Fynbos. The dendrogram shows that the Eastern Mountain Region is relatively heterogeneous (Fig. 59). The Suurberg (SU) and Grahamstown (GR) transects are very similar whereas the eastern coastal transects (EL and WE) show links with the coastal regions: the South-Western and Southern Coastal Mountain Regions. Linking communities include Afromontane Forest, Loerie and Bloukrans Mesic Proteoid Fynbos and Wet Proteoid Fynbos. The Baviaanskloof (BA) transect shows links with the Southern Interior Mountain Region.

The Southern Interior Mountain Region has a number of Grassy Fynbos and Grassy Shrubland links with the Eastern Mountain Region. However, it is essentially a region of Mesic Restioid Fynbos and Mesic Proteoid Fynbos. Also common is Mesotrophic and Oligotrophic Asteraceous Fynbos and Karroid & Renoster Shrubland. The Southern Interior Mountain Region has similarities with the Central and North-Western Mountain Regions. In common, are Oligotrophic and Talus Asteraceous Fynbos, Dry Restioid Fynbos, Dry Proteoid Fynbos, and Karroid & Renoster Shrubland.

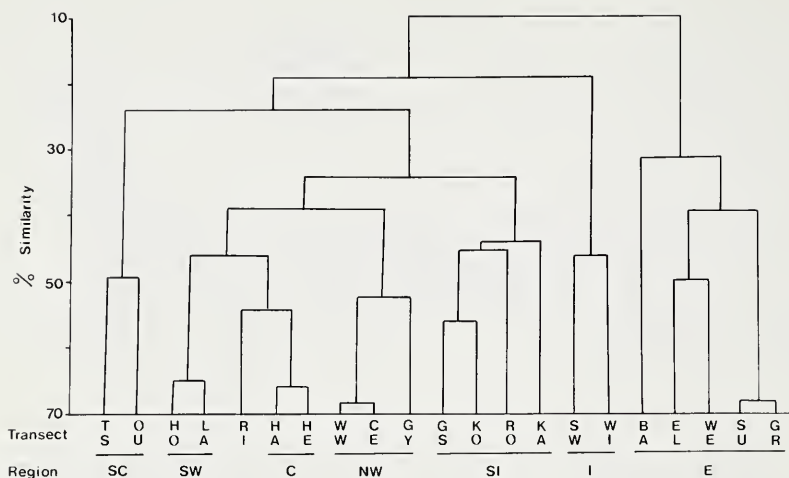


FIG. 59.—A numerical classification of transects showing the mountain regions recognized. In Table 27 the RI transect is placed with the South-Western Region. Abbreviations of regions and transects are as in Table 27 and Fig. 1. The numerical technique used was group-average sorting with the Czekanowski similarity coefficient (Campbell, 1978).

The Central and North-Western Mountain Regions both have much Dry and Azonal Restioid Fynbos, Dry Proteoid Fynbos and Oligotrophic and Talus Asteraceous Fynbos. The Central Mountain Region has, in addition, much Mesic Restioid Fynbos, giving it links with the Southern Interior and South-Western Mountain Regions. The North-Western Mountain Region is characterized by the dominance of Asteraceous Fynbos and Dry Restioid Fynbos.

The Interior Mountain Region is indicated to be rather peculiar (Fig. 59). It has much Mesotrophic and Dry Asteraceous Fynbos, whereas Restioid Fynbos and Proteoid Fynbos are largely lacking. The few links that exist are with the Southern Interior and North-Western Mountain Regions (e.g. Oligotrophic Asteraceous Fynbos, Karroid & Renoster Shrubland).

The two coastal regions, the South-Western and Southern Coastal Mountain Regions, are the two Ericaceous Fynbos regions. Common to the regions are various Ericaceous Fynbos types and Mesic Proteoid Fynbos. Both regions generally lack Asteraceous Fynbos. The Southern Coastal Mountain Regions also lacks Restioid Fynbos and it is to this region that Wet Proteoid Fynbos is largely confined. The region is dominated by Wet and Mesic Proteoid Fynbos and Wet and Mesic Ericaceous Fynbos. The South-Western Mountain Region has much Mesic Ericaceous Fynbos and Mesic and Azonal Restioid Fynbos.

At a higher level in the hierarchy, four major regions can be recognized: the Eastern Mountain Region (chiefly Grassy Fynbos); the Interior Mountain Region (chiefly Asteraceous Fynbos); a Restioid-Asteraceous Fynbos Mountain Region (comprising the North-Western, Central and Southern Interior Mountain Regions) and an Ericaceous Fynbos Mountain Region (comprising the South-Western and Southern Coastal Mountain Regions).

The mountain regions are neatly ordinated on the east-west gradient and the coast-interior gradient (Fig. 60). The climatic and edaphic variables associated with these gradients are described in Campbell (1983). The Interior Mountain Region is strongly associated with the quartzites of the Witteberg Group but the association is not perfect (e.g. the Gydo (GY) transect on Witteberg quartzites is placed in the North-Western Mountain Region).

Discussion

Previous attempts at regional subdivisions

The only previous attempt at a regional subdivision of the vegetation or flora of the mountains of the Fynbos Biome is the phytogeographical work of Weimark (1941). Kruger (1977) defined some further fynbos zones but his work was without a vegetation data-base. My mountain regions, defined by complexes of communities, show a broad similarity to Weimark's phytogeographical regions.

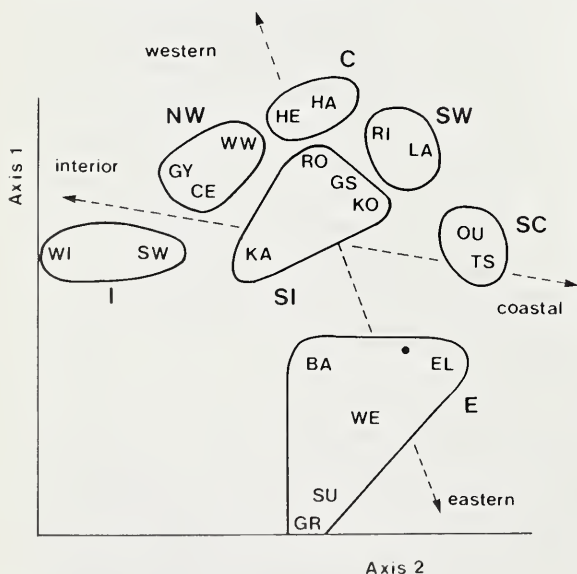


FIG. 60.—A Bray-Curtis ordination of the transects using the Czekanowski coefficient (Gauch, 1982). The regions recognized are superimposed. Abbreviations of regions and transects as in Table 27 and Fig. 1.

My Eastern Mountain Region corresponds closely with Weimarck's south-eastern centre except that he, inappropriately, I am sure, includes the Tsitsikamma (TS) in his centre and he excludes the Baviaanskloof (BA) from the Cape Floristic Region. My Interior Mountain Region is not distinguished by Weimarck. His Karoo mountain centre corresponds to my Southern Interior Mountain Region, and his north-western centre corresponds to my North-Western Mountain Region. The region covered by his Langeberg centre and south-western Cape centre corresponds to the region covered by my Central and South-Western Mountain Regions, but the boundaries between the two regions are very different.

Considering the different means of arriving at my mountain regions and Weimarck's phytogeographical regions, the correspondence between the systems is remarkable. The correspondence indicates that his broad floristic subdivision follows closely the major ecological regions in the Biome, despite the floristic complexity that occurs in the region. This does not, however, indicate that a floristic-based vegetation classification would approximate a structural-based classification. For instance,

the Ericaceous Fynbos of the Outeniqua Range is floristically unrelated to that of the Swartberg (Bond, 1981).

Eastern limits of the Fynbos Biome

The regional grouping of the transects shows the Eastern Mountain Region to be rather heterogeneous. However, that the transects do come together as a group at a relatively high similarity level suggests that the Suurberg (SU) and Grahamstown (GR) areas should be included in the Fynbos Biome and probably in the Cape Floristic Region. Given the close correspondence between quartzitic rocks of the Cape Supergroup and fynbos, further support for their inclusion in the Biome comes from the geology: the Grahamstown area represents the eastern extremity of the quartzites of the Cape Supergroup in the Southern Cape. Goldblatt (1978) excludes these areas from the Cape Floristic Region, whereas Werger (1978) includes these areas in the Cape Region. Kruger (1979b) follows Werger's conception of the Cape Region by including the Suurberg and Grahamstown areas in the Fynbos Biome.

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Appendix . Guide to using the classification

1. A prerequisite for using the classification is familiarity with the structural characters (Chapter 4). This requirement should be met by studying the examples that are cited.
2. Two methods are available for purposes of identifying the communities. The first is by using the keys in the present text as described in Methods (Chapter 3). These keys are found in the chapters referenced in Fig. 7. The second method is to use an aid available from the author. It is a FORTRAN computer program that can be modified for a programmable calculator for use in the field. Once the program is on a field calculator it should be an easier key to use than the first key and it should provide better identifications.
3. In using the keys, the data required for the key should be collected in a manner comparable to my data collection. A 10 m × 10 m plot is recommended, as every 1 m × 1 m represents 1% cover. Projected canopy cover should be estimated to the nearest actual cover, not on any cover scale (e.g. the Braun-Blanquet scale). In particular, attention should be paid to the lower and upper percentages (e.g. it is possible to estimate cover to 0.5%, 1%, 2%, 5%, 10%, 20%..... 80%, 90%, 95%, 99%, 100%). It is possible to get >100% cover for some characters, especially % cover by height class, total shrub cover and total graminoid cover, because these characters are summed from other cover characters where canopies overlap. For instance, Ericaceae may have 60% cover, other ericoids may have 20%, stroboids 15%, Penaeaceae 2%, other tall leptophylls 15%, other low leptophylls 5%, giving a total shrub cover of 117%. Note however, that total cover in a plot was not a summated character and therefore it runs from 1–100%.
4. Whichever key is used, the communities identified should be checked against the community descriptions and differentiated tables.

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